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PAT-NO: JP02002232005A

DOCUMENT-IDENTIFIER: JP 2002232005 A

TITLE: LIGHT EMITTING ELEMENT

PUBN-DATE: August 16, 2002

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APPL-NO: JP2001024946

APPL-DATE: January 31, 2001

INT-CL (IPC): H01L033/00

ABSTRACT:

PROBLEM TO BE SOLVED: To provide a light emitting element which can improve
light extraction efficiency, by using an oxide transparent electrode layer as
an electrode for light emission drive and also, adopting element structure that
can lessen the contact resistance of that electrode.

SOLUTION: For the light emitting element 100, a p-type GaAs layer 7 as an

electrode junction layer and an ITO electrode layer 8 as an oxide transparent
electrode layer are made in this order on the side of the first main surface 17
of a luminous layer part 24. Moreover, an n-type GaAs layer 9 as an electrode
junction layer and an ITO electrode layer 10 as an oxide transparent electrode
layer are made in this order on the side of the second main surface 18 of the
luminous layer part 24. The ITO electrode layers 8 and 10 are made in such
form as to form cover both main surfaces 17 and 18, severally, of the luminous
layer part 24 all over, together with the p-type GaAs layer 7 and the n-type
GaAs layer 9.

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(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号
特開2002－232005
（P2002－232005A）
(43)公開日　平成14年８月16日(2002.8.16)

(51)Int.Cl.'	識別記号	ＦＩ	テーマコード'(参考)
Ｈ０１Ｌ　33/00		Ｈ０１Ｌ　33/00	Ｅ　５Ｆ０４１
			Ｂ
			Ｃ

審査請求　未請求　請求項の数11　ＯＬ　（全 10 頁）

(21)出願番号　特願2001－24946(P2001－24946)

(22)出願日　平成13年１月31日(2001.1.31)

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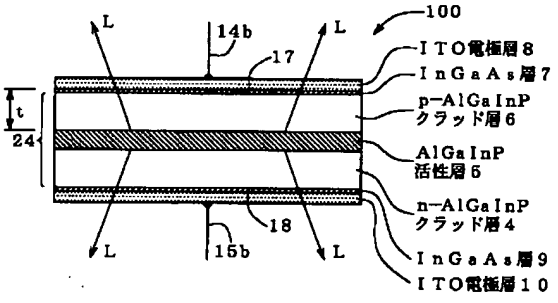
(54)【発明の名称】　発光素子

(57)【要約】
【課題】　発光駆動用の電極として酸化物透明電極層を用いるとともに、該電極の接触抵抗を小さくできる素子構造を採用することにより、光取出効率を改善できる発光素子を提供する。
【解決手段】　発光素子１００は、発光層部２４の第一主表面１７側に、電極接合層としてのｐ型ＧａＡｓ層７と酸化物透明電極層としてのＩＴＯ電極層８とがこの順序にて形成されている。また、発光層部２４の第二主表面１８側に、電極接合層としてのｎ型ＧａＡｓ層９と酸化物透明電極層としてのＩＴＯ電極層１０とがこの順序にて形成されている。ＩＴＯ電極層８，１０は、ｐ型ＧａＡｓ層７及びｎ型ＧａＡｓ層９とともに、発光層部２４の両主表面１７，１８のそれぞれ全面を覆う形にて形成されている。



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【特許請求の範囲】

【請求項１】　化合物半導体層からなる発光層部と、該発光層部に発光駆動電圧を印加するための酸化物透明電極層とを有し、前記発光層部からの光を、前記酸化物透明電極層を透過させる形で取り出すようにした発光素子において、前記発光層部と前記酸化物透明電極層との間に、該酸化物透明電極層と接する形にて、Ａｌを含有せず、かつバンドギャップエネルギーが１．４２ｅＶより小さい化合物半導体からなる電極接合層が形成されてなることを特徴とする発光素子。

【請求項２】　前記電極接合層を構成する化合物半導体は$In_xGa_{1-x}As$（$0<x\leqq1$）であることを特徴とする請求項１記載の発光素子。

【請求項３】　化合物半導体層からなる発光層部と、該発光層部に発光駆動電圧を印加するための酸化物透明電極層とを有し、前記発光層部からの光を、前記酸化物透明電極層を透過させる形で取り出すようにした発光素子において、前記発光層部と前記酸化物透明電極層との間に、該酸化物透明電極層と接する形にて、$In_xGa_{1-x}As$（$0<x\leqq1$）からなる電極接合層が形成されてなることを特徴とする発光素子。

【請求項４】　前記酸化物透明電極層は前記発光層部の全面を被覆する形にて形成されていることを特徴とする請求項１ないし３のいずれかに記載の発光素子。

【請求項５】　前記発光層部は、$(Al_xGa_{1-x})_yIn_{1-y}P$（但し、$0\leqq x\leqq1$，$0\leqq y\leqq1$）又は$In_xGa_yAl_{1-x-y}N$（$0\leqq x\leqq1$，$0\leqq y\leqq1$，$x+y\leqq1$）にて構成されていることを特徴とする請求項１ないし４のいずれかに記載の発光素子。

【請求項６】　前記発光層部は、各々前記$(Al_xGa_{1-x})_yIn_{1-y}P$又は前記$In_xGa_yAl_{1-x-y}N$にて構成される第一導電型クラッド層、活性層及び第二導電型クラッド層がこの順序にて積層されたダブルヘテロ構造を有し、前記第一導電型クラッド層及び前記第二導電型クラッド層の少なくともいずれかと前記酸化物透明電極層との間に、該酸化物透明電極層と接する形にて、該電極接合層が形成されてなることを特徴とする請求項１ないし５のいずれかに記載の発光素子。

【請求項７】　前記活性層が$(Al_xGa_{1-x})_yIn_{1-y}P$（但し、$0\leqq x\leqq0.55$，$0.45\leqq y\leqq0.55$）にて構成されることを特徴とする請求項６記載の発光素子。

【請求項８】　前記活性層は、バンドギャップエネルギーの異なる複数の化合物半導体層が積層された量子井戸構造を有することを特徴とする請求項６又は７に記載の発光素子。

【請求項９】　$In_xGa_{1-x}As$からなる前記電極接合層の厚さが０．００１～０．０２μｍの範囲に調整されていることを特徴とする請求項２ないし８のいずれかに記載の発光素子。

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【請求項１０】　前記酸化物透明電極層がＩＴＯ電極層であることを特徴とする請求項１ないし９のいずれかに記載の発光素子。

【請求項１１】　前記酸化物透明電極層がＺｎＯ電極層であることを特徴とする請求項１ないし９のいずれかに記載の発光素子。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】この発明は発光素子に関する。

【０００２】

【従来の技術】$(Al_xGa_{1-x})_yIn_{1-y}P$（但し、$0\leqq x\leqq1$，$0\leqq y\leqq1$（以下、ＡｌＧａＩｎＰ混晶、あるいは単にＡｌＧａＩｎＰとも記載する）混晶により発光層部が形成された発光素子は、薄いＡｌＧａＩｎＰ活性層を、それよりもバンドギャップの大きいｎ型ＡｌＧａＩｎＰクラッド層とｐ型ＡｌＧａＩｎＰクラッド層とによりサンドイッチ状に挟んだダブルヘテロ構造を採用することにより、高輝度の素子を実現できる。また、近年では、$In_xGa_yAl_{1-x-y}N$（但し、$0\leqq x\leqq1$，$0\leqq y\leqq1$，$x+y\leqq1$）を用いて同様のダブルヘテロ構造を形成した青色発光素子も実用化されている。

【０００３】例えば、図７（ａ）はＡｌＧａＩｎＰ発光素子の例であり、該素子３００においては、ｎ型ＧａＡｓ基板１上にヘテロエピタキシャル成長させる形にて、ｎ型ＧａＡｓバッファ層２、ｎ型ＡｌＧａＩｎＰクラッド層４、ＡｌＧａＩｎＰ活性層５、ｐ型ＡｌＧａＩｎＰクラッド層６がこの順序にて積層され、ダブルヘテロ構造をなす発光層部２４が形成されている。１４及び１５は、駆動電圧を印加するための金属電極である。ここで、金属電極１４は遮光体として作用するため、例えば発光層部主表面の中央部のみを覆う形で形成し、その周囲の電極非形成領域から光を取り出すようにしている。

【０００４】この場合、金属電極１４の面積をなるべく小さくしたほうが、電極１４の周囲に形成される光漏出領域の面積を大きくできるので、光取出し効率を向上させる観点において有利である。従来、電極形状の工夫により、素子内に効果的に電流を拡げて光取出量を増加させる試みがなされているが、この場合も電極面積の増大はいずれにしろ避けがたく、光漏出面積の減少により却って光取出量が制限されるジレンマに陥っている。また、クラッド層６のドーパント濃度ひいては導電率は、活性層５内でのキャリアの発光再結合を最適化するために多少低めに抑えられており、面内方向には電流が広がりにくい傾向がある。これは、電極被覆領域に電流密度が集中し、光漏出領域における実質的な光取出量が低下してしまうことにつながる。そこで、クラッド層６と電極１４との間に、ドーパント濃度を高めた低抵抗率の電

流拡散層１０７を形成する方法が採用されている。従来、このような電流拡散層１０７の材質としては、例えばＡｌＧａＡｓ混晶が使用されている。

【０００５】ＡｌＧａＡｓ混晶からなる電流拡散層１０７は、ＡｌＧａＩｎＰ混晶と格子整合するので成長炉内で高品質の半導体層として一貫成長できる利点はあるが、面内方向の電流密度分布を完全に均一化するには、図７（ｂ）に示すように、層厚ｂを５０μｍ程度とかなり厚く設定しなければならない。しかし、これでは成膜に必要な時間が長くなるとともに多量の原料を必要とするため、生産性が著しく低下するとともに高コスト化となり産業利用上の大きな問題となっている。また、素子表面から実際に発光する活性層５までの距離が大きくなりすぎ、直列抵抗増大により、発光効率が低下することに加え、高周波での動作特性が損なわれる不具合も生じていた。他方、図７（ｃ）に示すように、電流拡散層１０７の層厚ｂを小さくすると、電流拡散効果が逆に不足し、光漏出領域における実質的な光取出量が小さくなってしまうジレンマがある。

【０００６】そこで、ＡｌＧａＡｓ混晶からなる電流拡散層１０７の全面を、高導電率のＩＴＯ（Indium Tin Oxide：酸化インジウム錫）透明導電層にて覆い、電流拡散層１０７の層厚ｂを小さくしつつも十分な電流拡散効果を達成して、光取出効率を高める提案がなされている。

【０００７】

【発明が解決しようとする課題】しかしながら、本発明者らが検討したところによると、ＩＴＯからなる透明導電層をＡｌＧａＡｓ混晶からなる電流拡散層１０７上に形成した場合、透明導電層と電流拡散層１０７との接触抵抗が高くなりやすく、直列抵抗増大による発光効率の低下が避けがたくなることがわかった。

【０００８】本発明は、発光駆動用の電極として酸化物透明電極層を用いるとともに、該電極の接触抵抗を小さくできる素子構造を採用することにより、光取出効率を改善できる発光素子を提供することにある。

【０００９】

【課題を解決するための手段及び作用・効果】上記の課題を解決するために、本発明の発光素子の第一の構成は、化合物半導体層からなる発光層部と、該発光層部に発光駆動電圧を印加するための酸化物透明電極層とを有し、発光層部からの光を酸化物透明電極層を透過させる形で取り出すようにした発光素子において、発光層部と酸化物透明電極層との間に、該酸化物透明電極層と接する形にて、Ａｌを含有せず、かつバンドギャップエネルギーが１．４２ｅＶより小さい化合物半導体からなる電極接合層が形成されてなることを特徴とする。

【００１０】上記の構成によると、酸化物透明電極層を使用することにより、電流拡散層を用いることなく電流を効果的に発光素子領域全面に拡散することが可能となり、発光量を増大させることが可能となる。また、遮光性の金属電極に覆われた領域も、ワイヤーをボンディング（結合）するための最低限度の大きさに設計することが可能となり、電流を発光素子内に効果的に拡げるために電極のサイズを大きく設計していた従来の発光素子構造と比較して、光取出面積を増加させることができる。さらに、発光層部と酸化物透明電極層との間に、該酸化物透明電極層と接する形にて、Ａｌを含有せず、かつバンドギャップエネルギーが１．４２ｅＶより小さい化合物半導体からなる電極接合層を形成することにより、酸化物透明電極層の接触抵抗を大幅に減少させることができ、ひいては光取出効率を高めることができる。

【００１１】上記のような電極接合層を用いることにより、酸化物透明電極層の接触抵抗を低減できる理由として、本発明者らは以下の２つの理由を考えている。①従来の発光素子では、酸化物透明電極層はＡｌＧａＡｓ電流拡散層に接する形にて形成されていたが、電流拡散層の透光性を十分に確保するためには、ＡｌＡｓ混晶比を相当高めなければならない。しかしながら、高ＡｌＡｓ混晶比のＡｌＧａＡｓ混晶はＡｌを高濃度にて含有しているため非常に酸化され易く、酸化物透明電極層を形成すると、該層に含有される酸素がＡｌＧａＡｓ電流拡散層中のＡｌ成分と結合して高抵抗率の酸化層が形成される。②高ＡｌＡｓ混晶比のＡｌＧａＡｓ混晶は、混晶比にもよるが、電流拡散層として通常使用されるものにおいては、バンドギャップエネルギーが２．０２～２．１３ｅＶと高いので、酸化物透明電極層との間でオーミック接触又はそれに近い低抵抗率の接触（例えば10^{-4}Ω・ｃｍ以下：以下、これらを総称してオーミック状接触という）が形成されにくい。また、ＡｌＧａＡｓを用いずにＡｌＧａＩｎＰクラッド層上に直接酸化物透明電極層を接触させた場合にもバンドギャップエネルギーが２．３～２．３５ｅＶと高くかつＡｌを含有するため、上記ＡｌＧａＡｓの場合と同様の問題が生ずる。

【００１２】本発明の第一の構成の発光素子によると、酸化物透明電極層と接する電極接合層がＡｌを含有しないので高抵抗率の酸化層は形成されにくく、かつ、バンドギャップエネルギーも小さい（１．４２ｅＶ未満；例えば$In_{0.5}Ga_{0.5}As$を採用した場合、０．７５ｅＶ）のでオーミック状接触を容易に実現できる。その結果、透明電極層の接触抵抗を大幅に低減することができる。

【００１３】また、本発明の発光素子の第二の構成は、化合物半導体層からなる発光層部と、該発光層部に発光駆動電圧を印加するための酸化物透明電極層とを有し、発光層部からの光を、酸化物透明電極層を透過させる形で取り出すようにした発光素子において、発光層部と酸化物透明電極層との間に、該酸化物透明電極層と接する形にて、$In_xGa_{1-x}As$（$0<x\leq 1$）からなる電極接合層が形成されてなることを特徴とする。該構成

も酸化物透明電極層を使用しているので、第一の構成と同様に、光取出面積を増加させることができる。また、発光層部と酸化物透明電極層との間に$In_xGa_{1-x}As$からなる電極接合層を形成することにより、酸化物透明電極層の接触抵抗を大幅に減少させることができ、ひいては光取出効率を飛躍的に高めることができる。

【0014】図9は：

①AlGaAs層もしくはAlGaInP層上に直接ITO透明電極を形成した発光素子；

②AlGaAs上にGaAs層（バンドギャップ1.42eV）を介してITO透明電極層を形成した発光素子；及び、

③$In_{0.5}Ga_{0.5}As$電極接合層を介してITO透明電極層を形成した本発明の発光素子；

の、それぞれの電流電圧特性を示すものである。ITO透明電極層にGaAs層を接触させた②では、直列抵抗成分の低下によりVF値（ある特定の電流値を流すのに必要な電圧の値）が①と比較して低下しているが、依然、多少高めの値を示している。これに対し、GaAsよりもバンドギャップエネルギーが小さいInGaAs層を利用した③（本発明）では、VFの低下がより顕著であり、実用的なレベルに到達していることがわかる。

【0015】上記本発明の発光素子の第一及び第二の構成において、酸化物透明電極層の材質は、酸化スズ（SnO_2）あるいは酸化インジウム（In_2O_3）を主体とするものを使用できる。具体的には、酸化物透明電極層は、ITOが高導電率であり、本発明に好適に使用できる。ITOは、酸化スズをドープした酸化インジウム膜であり、酸化スズの含有量を1～9質量%とすることで、電極層の抵抗率を$5\times10^{-4}\Omega\cdot cm$以下の十分低い値とすることができる。なお、ITO電極層以外では、ZnO電極層が高導電率であり、本発明に採用可能である。また、酸化アンチモンをドープした酸化スズ（いわゆるネサ）、Cd_2SnO_4、Zn_2SnO_4、$ZnSnO_3$、$MgIn_2O_4$、酸化イットリウム（Y）をドープした$CdSb_2O_6$、酸化スズをドープした$GaInO_3$なども酸化物透明電極層の材質として使用することができる。

【0016】これらの酸化物透明電極層は、公知の気相成膜法、例えば化学蒸着法（chemicalvapor deposition：CVD）あるいはスパッタリングや真空蒸着などの物理蒸着法（physical vapor deposition：PVD）、あるいは分子線エピタキシャル成長法（molecularbeam epitaxy：MBE）にて形成することができる。例えば、ITO電極層やZnO電極層は高周波スパッタリング又は真空蒸着により製造でき、また、ネサ膜はCVD法により製造できる。また、これら気相成長法に代えて、ゾルーゲル法など他の方法を用いて形成してもよい。

【0017】酸化物透明電極層は、発光層部の全面を被覆する形にて形成することができる。このように構成すると、酸化物透明電極層に電流拡散層の機能を担わせることができ、従来のような化合物半導体からなる厚い電流拡散層の形成が不要となったり、仮に形成する場合でも、その厚みを大幅に減ずることができるから、工程の簡略化によるコスト削減に寄与し、産業利用上非常に有効である。他方、電極接合層の形成厚さは、オーミック接触を形成するために必要十分な程度であれば、それほど厚くする必要がなく、また、具体的には、電極接合層を構成する化合物半導体が、薄層化によりバルク結晶とは異なるバンドギャップエネルギーを示すようにならない程度の厚さを確保すればよく、例えば$In_xGa_{1-x}As$を用いる場合であれば、0.001μm程度もあれば十分である。従って、酸化物透明電極層と発光層部との層間距離を従来の発光素子よりも大幅に縮めることができ、それによる直列抵抗低減効果を最小限に低下することが可能となる。なお、$In_xGa_{1-x}As$からなる電極接合層の厚さを過剰に大きくすることは、該電極接合層における光吸収が増大する結果、光取出効率の低下を招くので、0.02μm以下とすることが望ましい。

【0018】また、$(Al_xGa_{1-x})_yIn_{1-y}P$（但し、$0\leqq x\leqq1$，$0\leqq y\leqq1$）又は$In_xGa_yAl_{1-x-y}N$（但し、$0\leqq x\leqq1$，$0\leqq y\leqq1$，$x+y\leqq1$）からなる発光層部はいずれも殆どの場合にAlを含有するので、酸化劣化の問題を考慮しなければならないが、酸化物透明電極層にて全面的に覆う構成を採用することで、該酸化物透明電極層を上記Alを含有する発光層部に対するパッシベーション膜としても機能させることができる利点がある。

【0019】なお、$In_xGa_{1-x}As$は、混晶比によっては上記発光層部をなす化合物半導体（あるいはGaAs）との格子定数の差が多少大きくなる化合物半導体ではあるが、厚さ0.001～0.02μm程度の薄層として形成する場合は、格子不整合の影響を比較的小さく留めることができるので、該化合物半導体を用いて電極接合層を形成することが可能である。

【0020】なお、化合物半導体層を用いて酸化物透明電極層と直接接する電極接合層を形成する場合、該透明電極層とのオーミック状接触を良好に形成する観点から、前述の通り、バンドギャップエネルギーが1.42eVより小さい化合物半導体を用いることが望ましい。そして、上記のような薄層化による格子不整合の影響軽減により、InGaAsのほかにInP、InAs、GaSb、InSbまたはそれらの混晶を用いることも可能である。

【0021】$(Al_xGa_{1-x})_yIn_{1-y}P$又は$In_xGa_yAl_{1-x-y}N$からなる発光層部は、各々$(Al_xGa_{1-x})_yIn_{1-y}P$又は$In_xGa_yAl_{1-x-y}N$にて構成される第一導電型クラッド

層、活性層及び第二導電型クラッド層がこの順序にて積層されたダブルヘテロ構造を有するものとして形成できる。活性層の両側に形成されるクラッド層とのバンドギャップ差に起因したエネルギー障壁により、注入されたホールと電子とが狭い活性層中に閉じ込められて効率よく再結合するので、非常に高い発光効率を実現できる。さらに、活性層の組成調整により、前者は緑色から赤色領域（ピーク発光波長が５２０ｎｍ以上６７０ｎｍ以下）にかけて、後者は紫外領域から赤色（ピーク発光波長が３００ｎｍ以上７００ｎｍ以下）にかけての、それぞれ広範囲の発光波長を実現することができる。

【００２２】そして、上記構成においては、第一導電型クラッド層及び第二導電型クラッド層の少なくともいずれかと接する位置に電極接合層を形成することができる。例えば、ダブルヘテロ構造からなる発光層部の片側の主表面のみを光取出面として使用する場合は、該側に位置するクラッド層と酸化物透明電極層との間に該酸化物透明電極と接する形にて電極接合層を形成して、酸化物透明電極層を形成することができる。他方、発光層部の両側の主表面を光取出面として使用する場合は、両側のクラッド層のそれぞれに対応して酸化物透明電極を形成するとともに、各酸化物透明電極とクラッド層との間には、酸化物透明電極に接する電極接合層を形成することができる。

【００２３】

【発明の実施の形態】以下、本発明の実施の形態を添付の図面を参照して説明する。図１は、本発明の一実施形態である発光素子１００を示す概念図である。発光素子１００は、発光層部２４の第一主表面１７側に、電極接合層としてのＩｎＧａＡｓ層７と酸化物透明電極層としてのＩＴＯ電極層８とがこの順序にて形成されている。また、発光層部２４の第二主表面１８側に、電極接合層としてのＩｎＧａＡｓ層９と酸化物透明電極層としてのＩＴＯ電極層１０とがこの順序にて形成されている。ＩＴＯ電極層８，１０は、ＩｎＧａＡｓ層７及びＩｎＧａＡｓ層９とともに、発光層部２４の両主表面１７，１８のそれぞれ全面を覆う形にて形成されている。

【００２４】発光層部２４は、各々（$Al_xGa_{1-x})_yIn_{1-y}P$混晶とされるとともに、第一導電型クラッド層６、第二導電型クラッド層４、及び第一導電型クラッド層６と第二導電型クラッド層４との間に位置する活性層５からなるダブルヘテロ構造とされている。具体的には、ノンドープ（$(Al_xGa_{1-x})_yIn_{1-y}P$（但し、$0 \leqq x \leqq 0.55$，$0.45 \leqq y \leqq 0.55$）混晶からなる活性層５を、ｐ型（$(Al_xGa_{1-x})_yIn_{1-y}P$クラッド層６とｎ型（$(Al_xGa_{1-x})_yIn_{1-y}P$クラッド層４とにより挟んだ構造となっている。図１の発光素子１００では、ＩＴＯ電極層８側にｐ型ＡｌＧａＩｎＰクラッド層６が配置されており、ＩＴＯ電極層１０側にｎ型ＡｌＧａＩｎＰクラッド層４が配置されている。従って、通電極性はＩＴＯ電極層８側が正である。なお、当業者には自明のことであるが、ここでいう「ノンドープ」とは、「ドーパントの積極添加を行なわない」との意味であり、通常の製造工程上、不可避的に混入するドーパント成分の含有（例えば10^{13}～10^{16}／cm^3程度を上限とする）をも排除するものではない。

【００２５】なお、図１の発光素子１００において、各層の厚さの実例として以下のような数値を例示できる：

・ＩｎＧａＡｓ層７＝厚さ：約０．００５μｍ
・ＩＴＯ電極層８＝厚さ：０．２μｍ、酸化スズ含有率：７質量％（残部酸化インジウム）；
・ｐ型ＡｌＧａＩｎＰクラッド層６＝１μｍ；
・ＡｌＧａＩｎＰ活性層５＝０．６μｍ；
・ｎ型ＡｌＧａＩｎＰクラッド層４＝１μｍ；
・ＩｎＧａＡｓ層９＝厚さ：約０．００５μｍ
・ＩＴＯ電極層１０＝ＩＴＯ電極層８と同一構成。

【００２６】以下、図１の発光素子１００の製造方法について説明する。まず、図３に示すように、ＡｌＧａＩｎＰ混晶と格子整合する化合物半導体単結晶基板であるＧａＡｓ単結晶基板１の第一主表面１ａに、ｎ型ＧａＡｓバッファ層２を例えば０．５μｍ、次いで、発光層部２４として、１μｍのｎ型ＡｌＧａＩｎＰクラッド層４、０．６μｍのＡｌＧａＩｎＰ活性層（ノンドープ）５、及び１μｍのｐ型ＡｌＧａＩｎＰクラッド層６、さらにＩｎＧａＡｓ層７をｐ型ＡｌＧａＩｎＰクラッド層６上に厚さ０．００５μｍにてエピタキシャル成長させる。これら各層のエピタキシャル成長は、公知の有機金属気相エピタキシャル成長（Metalorganic Vapor Phase Epitaxy:ＭＯＶＰＥ）法により行なうことができる。

【００２７】上記の成長後、例えば硫酸系水溶液（濃硫酸：３０％過酸化水素水：水＝３：１：１容量比）からなるエッチング液に浸漬することにより、ＧａＡｓ基板１およびＧａＡｓバッファ層２をエッチング除去することができる（図４（ａ））。そして、同図（ｂ）に示すように、そのエッチング剥離された側において、ｎ型ＡｌＧａＩｎＰクラッド層４の主表面１８に、ＩｎＧａＡｓ層９を、ＭＯＶＰＥ法により厚さ０．００５μｍにてエピタキシャル成長させる。

【００２８】そして、それぞれのＩｎＧａＡｓ層７及びＩｎＧａＡｓ層９の両主表面に、公知の高周波スパッタリング法（ターゲット組成（In_2O_3＝９０．２重量％，SnO_2＝９．８重量％）、ｒｆ周波数１３．５６ＭＨｚ、Ａｒ圧力０．６Ｐａ、スパッタ電力３０Ｗ）により、ＩＴＯ電極層８，１０をそれぞれ厚さ０．２μｍにて形成し、積層体ウェーハ１３を得る。なお、膜形成後に窒素雰囲気中３００℃～５００℃の温度で熱処理を施すことにより、約１桁抵抗率を低減することができる。積層体ウェーハ１３はダイシングにより半導体チップとされ、支持体に固着した後、図１に示すようにリー

ド線14b，15bを取り付け、さらに図示しない樹脂封止部を形成することにより発光素子100が得られる。

【0029】上記発光素子100によると、p型AlGaInPクラッド層6及びn型AlGaInPクラッド層4の全面が、それぞれInGaAs層7及びInGaAs層9を介してITO電極層8及びITO電極層10により覆われてなり、これらITO電極層8，10を介して駆動電圧が印加される。駆動電圧による駆動電流は導電性の良好なITO電極層8，10の全面に均一に拡散するので、光取出面（両主表面17，18）の全体にわたって均一な発光が得られるとともに、電極層8，10が透明なので光取出効率が向上する。さらに、ITO電極層8，10は、バンドギャップが比較的狭いInGaAs層7及びInGaAs層9に対しオーミック状接触状態を形成するため、接触部の直列抵抗が小さく抑えられ、発光効率が大幅に高められている。

【0030】さらに、従来の発光素子のような厚い電流拡散層が不要となるため、ITO電極層（酸化物透明電極層）と発光面までの距離を大幅に短くできる。その結果、直列抵抗の低減を図ることができる。なお、発光面は、以下のように定義する。まず、発光層部24が上記のようなダブルヘテロ構造を有する場合には、酸化物透明電極層（ITO電極層）に近い側のクラッド層／活性層界面（ITO電極層8からみればp型クラッド層6と活性層5と界面であり、ITO電極層10からみればn型クラッド層4と活性層5と界面である）を発光面として定義する。他方、本発明は、上記のようなダブルヘテロ構造型の発光層部を有するものに限らず、シングルヘテロ構造型の発光部を有する発光素子にも適用可能であるが、この場合は、そのヘテロ接合界面を発光面として定義する。そして、本発明の採用により、酸化物透明電極層と電極接合層との界面から発光面までの距離t（図1参照）は、具体的には3μm以下の小さな値とすることが可能となる。

【0031】電極接合層であるInGaAs層7あるいはInGaAs層9は、適当なドーパントの添加により、これと接する各クラッド層6，4とそれぞれ同じ導電型を有するものとして形成してもよいが、InGaAs層7あるいはInGaAs層9を上記のような薄層として形成する場合は、これらをドーパント濃度の低い低ドープ層（例えば10^{17}個／cm^3以下；あるいはノンドープ層（10^{13}個／cm^3～10^{16}個／cm^3）として形成しても直列抵抗の過度の増加を招かないので、問題なく採用可能である。他方、低ドープ層とした場合、発光素子の駆動電圧によっては、以下のような効果が達成できる。すなわち、電極接合層を低ドープ層とすることで、層の電気抵抗率自体は高くなるので、これを挟む電気抵抗率の小さいクラッド層あるいはITO層に対して、電極接合層の層厚方向に印加される電界（すなわち、単位距離当たりの電圧）が相対的に高くなる。このとき、電極接合層を、バンドギャップの比較的小さいInGaAsにより形成しておくと、上記電界の印加により電極接合層のバンド構造に適度な曲がりが生じ、より良好なオーミック状接合を形成することができる。

【0032】なお、InGaAs層とAlGaInP層とを直接接合した場合、接合界面にやや高いヘテロ障壁が形成され、これに起因して直列抵抗成分が増大する場合がありうる。そこで、これを低減する目的で、図8に示す発光素子150のように、酸化物透明電極（ITO電極層）8と接するInGaAs電極接合層7と、AlGaInPクラッド層6との間に、GaAs層19、AlGaAs層20、AlGaInP層21等からなる中間層を必要に応じて挿入することができる。この構造を採用する場合でも、それら中間層の厚さはそれぞれ0.1μm程度以下とすることが可能なため、薄層化によるエピタキシャル成長時間の短縮、ひいては生産性の向上を図ることができ、中間層形成による直列抵抗の増分も少なくできるため、発光効率も損なわれにくい。

【0033】なお、図5に示す発光素子50のように、ダブルヘテロ構造層からなる発光層部24に、その片側にのみ電極接合層（例えばInGaAs層）及び酸化物透明電極層（ITO電極層）を接合してもよい。この場合は、n型GaAs基板1は素子基板に流用され、その第一主表面側にInGaAs層7及びITO電極層8が形成される。また、図6に示す発光素子51のように、GaAs基板1と発光層部24との間に、例えば特開平7-66455号公報に開示されている半導体多層膜や、あるいはAuないしAu合金にて構成された金属層を反射層16として挿入することができる。これにより、発光層部24から直接光取出層側に漏出する光Lに加え、反射層16での反射光L'が加わるので、光取出効率を高めることができる。また、全反射損失をさらに低減するために、特開平5-190893号公報に開示されているように、発光層部と光取出層との界面を光取出方向に向けて凸状に湾曲させることもできる。

【0034】図1の発光素子100においては、ダブルヘテロ構造をなす発光層部24の各層をAlGaInP混晶にて形成していたが、図2に示すように、ダブルヘテロ構造をなす発光層部124の各層（p型クラッド層106、活性層105及びn型クラッド層104）をAlGaInN混晶により形成することにより、青色あるいは紫外発光用のワイドギャップ型発光素子200を構成することもできる。発光層部124は、図1の発光素子100と同様にMOVPE法により形成される。該図2の発光素子200は、発光層部124を除き、残りの部分は図1の発光素子100と同一構成であるので、詳細な説明は省略する。

【0035】また、活性層5あるいは105は上記実施

形態では単一層として形成していたが、これを、バンドギャップエネルギーの異なる複数の化合物半導体層が積層されたもの、具体的には、図１０（ａ）に示すような量子井戸構造を有するものとして構成することもできる。量子井戸構造を有する活性層は、図１０（ｂ）及び（ｃ）に示すように、混晶比の調整によりバンドギャップが互いに相違する２層、すなわちバンドギャップエネルギーの小さい井戸層Ｂと大きい障壁層Ａとを、各々電子の平均自由工程もしくはそれ以下の厚さ（一般に、１原子層～数１０Å）となるように格子整合させる形で積層したものである。上記構造では、井戸層Ｂの電子（あるいはホール）のエネルギーが量子化されるため、例えば半導体レーザー等に適用した場合に、発振波長をエネルギー井戸層の幅や深さにより自由に調整でき、また、発振波長の安定化、発光効率の向上、さらには発振しきい電流密度の低減などに効果がある。さらに、井戸層Ｂと障壁層Ａとは厚さが非常に小さいため、２～３％程度までであれば格子定数のずれが許容され、発振波長領域の拡大も容易である。なお、量子井戸構造は、（ｂ）に示すように、井戸層Ｂを複数有する多重量子井戸構造としてもよいし、（ｃ）に示すように、井戸層Ｂを１層のみ有する単一量子井戸構造としてもいずれでもよい。図では、ｐ型及びｎ型の各クラッド層を（$Al_{0.7}Ga_{0.3})_{0.5}In_{0.5}P$混晶により、障壁層Ａを（$Al_{0.5}Ga_{0.5})_{0.5}In_{0.5}P$混晶により、井戸層Ｂを（$Al_{0.2}Ga_{0.8})_{0.5}In_{0.5}P$混晶によりそれぞれ構成している。なお、障壁層Ａの厚さは、例えばクラッド層と接するもののみ５００Å程度とし、他は６０Å程度とすることができる。また、井戸層Ｂは５０Å程度とすることができる。

【００３６】以上、本発明の実施の形態を示したが、本発明は何らこれに限定されることはなく、特許請求の範囲の記載事項を逸脱しない限り、種々の改良あるいは変更を加えることができる。例えば、上記実施形態では、発光層部をＡｌＧａＩｎＰ混晶あるいはＡｌＧａＩｎＮ混晶により形成していたが、ＧａＰ、ＧａＡｓＰあるいはＡｌＧａＡｓなど、他の化合物半導体により発光層部を形成してもよく、この場合も、前記した本発明の効果を達成することができる。

【図面の簡単な説明】

【図１】本発明の発光素子の一例を積層構造にて示す模式図。

【図２】本発明の発光素子の別例を積層構造にて示す模式図。

【図３】図１の発光素子の製造工程を示す模式図。

【図４】図３に続く模式図。

【図５】発光層部の第一主表面にのみ電極接合層及び酸化物透明電極層を形成した素子構造の例を示す模式図。

【図６】図５において、光取出層の第二主表面側に反射層を挿入した素子構造の例を示す模式図。

【図７】従来の発光素子の構造と問題点とを示す説明図。

【図８】電極接合層とクラッド層との間に中間層を形成した素子構造の例を示す模式図。

【図９】ＡｌＧａＩｎＰとＩＴＯ電極層との間に各種の電極接合層を設けた場合の、それぞれのＶＦ値を示すＩ－Ｖ特性図。

【図１０】量子井戸構造を有する活性層の模式図。

【符号の説明】

４　ｎ型ＡｌＧａＩｎＰクラッド層（第二導電型クラッド層）

５　ＡｌＧａＩｎＰ活性層

６　ｐ型ＡｌＧａＩｎＰクラッド層（第一導電型クラッド層）

７　ＩｎＧａＡｓ層（電極接合層）

８　ＩＴＯ電極層（酸化物透明電極層）

９　ＩｎＧａＡｓ層（電極接合層）

１０　ＩＴＯ電極層（酸化物透明電極層）

２４　発光層部

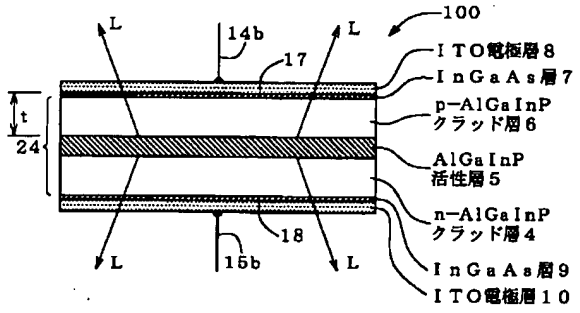
１０４　ｎ型ＡｌＧａＩｎＮクラッド層（第二導電型クラッド層）

１０５　ＡｌＧａＩｎＮ活性層

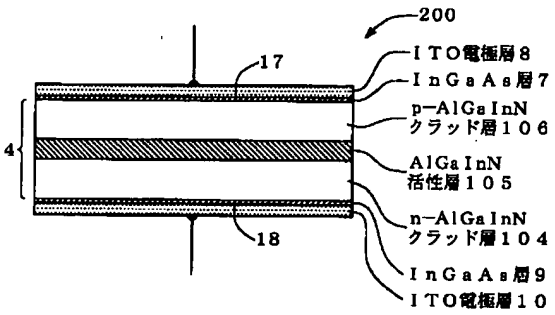
１０６　ｐ型ＡｌＧａＩｎＮクラッド層（第一導電型クラッド層）

５０，５１，１００，２００　発光素子

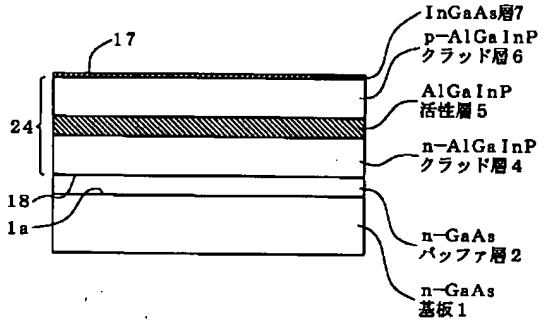
【図1】


100
L
14b
L
17
ITO電極層8
InGaAs層7
p-AlGaInP
クラッド層6
t
24
AlGaInP
活性層5
n-AlGaInP
クラッド層4
18
L
15b
L
InGaAs層9
ITO電極層10

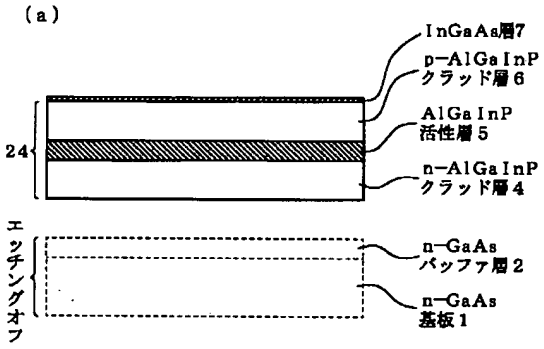
【図2】

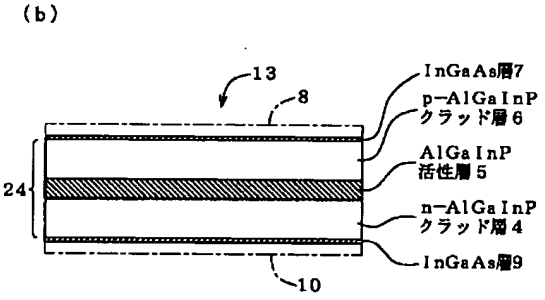

200
17
ITO電極層8
InGaAs層7
p-AlGaInN
クラッド層106
4
AlGaInN
活性層105
18
n-AlGaInN
クラッド層104
InGaAs層9
ITO電極層10

【図3】

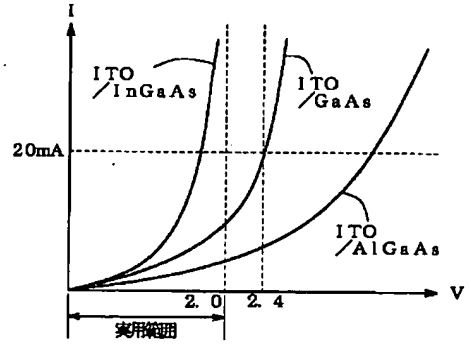

InGaAs層7
17
p-AlGaInP
クラッド層6
AlGaInP
活性層5
24
n-AlGaInP
クラッド層4
18
1a
n-GaAs
バッファ層2
n-GaAs
基板1

【図4】

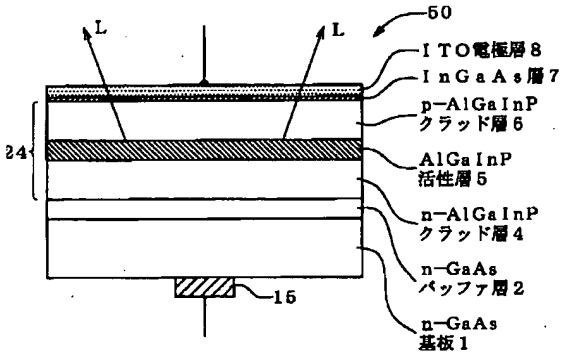

(a)
InGaAs層7
p-AlGaInP
クラッド層6
AlGaInP
活性層5
24
n-AlGaInP
クラッド層4
エッチングオフ
n-GaAs
バッファ層2
n-GaAs
基板1


(b)
13
8
InGaAs層7
p-AlGaInP
クラッド層6
AlGaInP
活性層5
24
n-AlGaInP
クラッド層4
InGaAs層9
10

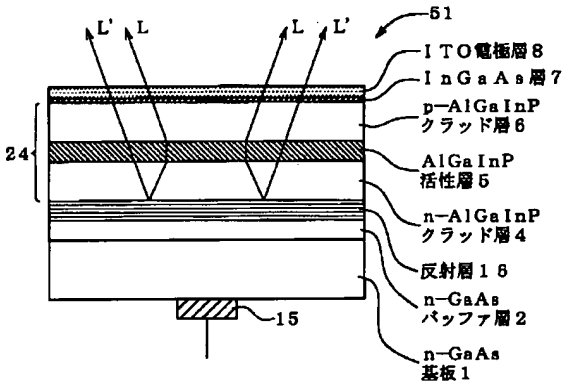
【図9】


I
ITO
/InGaAs
ITO
/GaAs
20mA
ITO
/AlGaAs
2.0
2.4
V
実用範囲

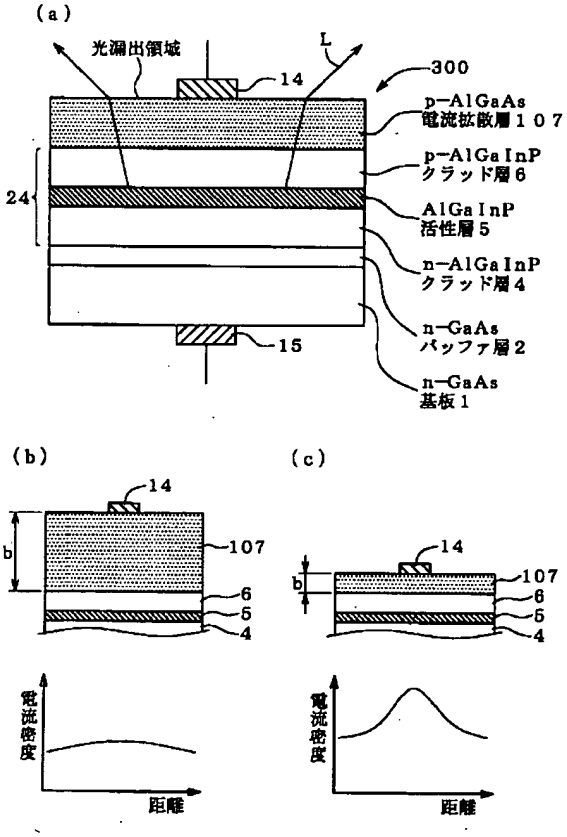
【図5】


50
L
L
ITO電極層8
InGaAs層7
p-AlGaInP
クラッド層6
24
AlGaInP
活性層5
n-AlGaInP
クラッド層4
n-GaAs
バッファ層2
15
n-GaAs
基板1

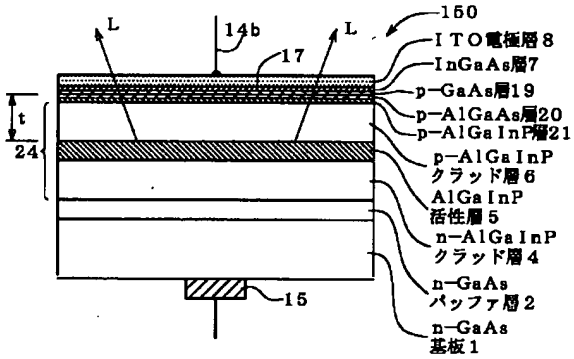
【図6】


51
L'
L
L
L'
ITO電極層8
InGaAs層7
p-AlGaInP
クラッド層6
24
AlGaInP
活性層5
n-AlGaInP
クラッド層4
反射層16
n-GaAs
バッファ層2
15
n-GaAs
基板1

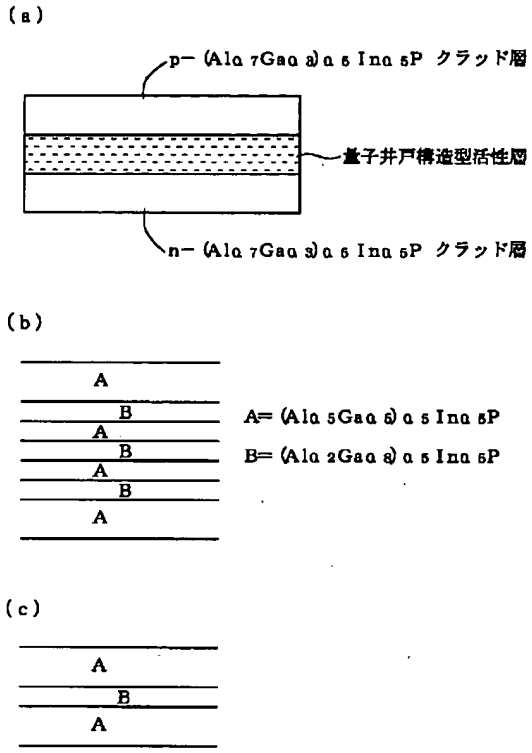
【図7】


(a)
光漏出領域
L
14
300
p-AlGaAs
電流拡散層107
p-AlGaInP
クラッド層6
24
AlGaInP
活性層5
n-AlGaInP
クラッド層4
n-GaAs
バッファ層2
15
n-GaAs
基板1
(b)
14
b
107
6
5
4
電流密度
距離
(c)
14
b
107
6
5
4
電流密度
距離

【図8】


150
L
14b
17
L
ITO電極層8
InGaAs層7
p-GaAs層19
p-AlGaAs層20
p-AlGaInP層21
t
24
p-AlGaInP
クラッド層6
AlGaInP
活性層5
n-AlGaInP
クラッド層4
n-GaAs
バッファ層2
15
n-GaAs
基板1

【図10】



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Ｆターム(参考)　5F041 AA08 AA21 CA34 CA40 CA88 CA91

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2002-232005

(43)Date of publication of application : 16.08.2002

(51)Int.Cl. H01L 33/00

(21)Application number : 2001-024946

(22)Date of filing : 31.01.2001

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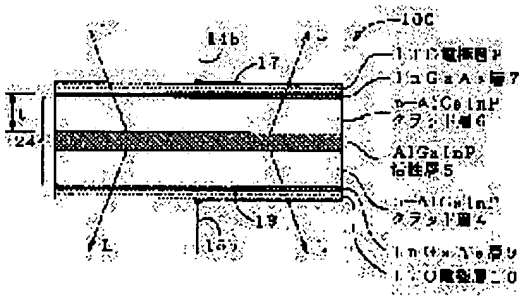
(54) LIGHT EMITTING ELEMENT

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a light emitting element which can improve light extraction efficiency, by using an oxide transparent electrode layer as an electrode for light emission drive and also, adopting element structure that can lessen the contact resistance of that electrode.

SOLUTION: For the light emitting element 100, a p-type GaAs layer 7 as an electrode junction layer and an ITO electrode layer 8 as an oxide transparent electrode layer are made in this order on the side of the first main surface 17 of a luminous layer part 24. Moreover, an n-type GaAs layer 9 as an electrode junction layer and an ITO electrode layer 10 as an oxide transparent electrode layer are made in this order on the side of the second main surface 18 of the luminous layer part 24. The ITO electrode layers 8 and 10 are made in such form as to form cover both main surfaces 17 and 18, severally, of the luminous layer part 24 all over, together with the p-type GaAs layer 7 and the n-type GaAs layer 9.



LEGAL STATUS

[Date of request for examination] 04.12.2003

h c g e e h

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] In the light emitting device which has the luminous layer section which consists of a compound semiconductor layer, and an oxide transparent electrode layer for impressing luminescence driver voltage to this luminous layer section, and took out the light from said luminous layer section in the form where said oxide transpar electrode layer is made to penetrate The light emitting device characterized by coming to form the electrode junction zone which aluminum is not contained in the form which touches this oxide transparent electrode layer, and bandgap energy becomes from a compound semiconductor smaller than 1.42eV between said luminous layer section and said oxide transparent electrode layer.
[Claim 2] The compound semiconductor which constitutes said electrode junctional zone is a light emitting device according to claim 1 characterized by being InxGa1-xAs (0< x<=1).
[Claim 3] In the light emitting device which has the luminous layer section which consists of a compound semiconductor layer, and an oxide transparent electrode layer for impressing luminescence driver voltage to this luminous layer section, and took out the light from said luminous layer section in the form where said oxide transpar electrode layer is made to penetrate The light emitting device characterized by coming to form the electrode junction zone which consists of InxGa1-xAs (0< x<=1) in the form which touches this oxide transparent electrode layer betw said luminous layer section and said oxide transparent electrode layer.
[Claim 4] Said oxide transparent electrode layer is a light emitting device according to claim 1 to 3 characterized by being formed in the form which covers the whole surface of said luminous layer section.
[Claim 5] Said luminous layer section is a light emitting device according to claim 1 to 4 characterized by consisting yIn(AlxGa 1-x)1-yP (however, 0<=x<=1, 0<=y<=1) or InxGayAl1-x-yN (0<=x<=1, 0<=y<=1, x+y<=1).
[Claim 6] The first conductivity-type cladding layer by which said luminous layer section is respectively constituted from aforementioned yIn1-yP or said aforementioned (AlxGa 1-x) InxGayAl1-x-yN, A barrier layer and the second conductivity-type cladding layer have terrorism structure to the double by which the laminating was carried out in th sequence. Said first conductivity-type cladding layer and said second conductivity-type cladding layer at least betwe either and said oxide transparent electrode layer The light emitting device according to claim 1 to 5 characterized by coming to form this electrode junctional zone in the form which touches this oxide transparent electrode layer.
[Claim 7] The light emitting device according to claim 6 characterized by said barrier layer consisting of yIn(AlxGa x)1-yP(s) (however, 0<=x<=0.55, 0.45<=y<=0.55).
[Claim 8] Said barrier layer is a light emitting device according to claim 6 or 7 characterized by having the quantum well structure where the laminating of two or more compound semiconductor layers from which bandgap energy diff was carried out.
[Claim 9] The light emitting device according to claim 2 to 8 characterized by being adjusted to the range said whose electrode junction layer thickness which consists of InxGa1-xAs is 0.001-0.02 micrometers.
[Claim 10] The light emitting device according to claim 1 to 9 characterized by said oxide transparent electrode laye being an ITO electrode layer.
[Claim 11] The light emitting device according to claim 1 to 9 characterized by said oxide transparent electrode laye being a ZnO electrode layer.

[Translation done.]

h c g cg b eb cg e e h c g

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a light emitting device.
[0002]
[Description of the Prior Art] (AlxGa 1-x) yIn1-yP (however, the light emitting device in which the luminous layer section was formed with 0<=x<=1 and 0<=y<=1 (following and AlGaInP mixed crystal -- or it is only indicated also AlGaInP) mixed crystal can realize the component of high brightness by adopting terrorism structure to the double which sandwiched the thin AlGaInP barrier layer in the shape of sandwiches by the n mold AlGaInP cladding layer with a larger band gap than it, and the p mold AlGaInP cladding layer.) Moreover, in recent years, the blue light emitting device which formed terrorism structure in the same double using InxGayAl1-x-yN (however, 0<=x<=1, 0<=y<=1, x+y<=1) is also put in practical use.
[0003] For example, drawing 7 (a) is the example of an AlGaInP light emitting device, in this component 300, in the form which carries out heteroepitaxial growth on the n mold GaAs substrate 1, the laminating of the n mold GaAs buffer layer 2, the n mold AlGaInP cladding layer 4, the AlGaInP barrier layer 5, and the p mold AlGaInP cladding layer 6 is carried out in this sequence, and the luminous layer section 24 which makes terrorism structure to double i formed. 14 and 15 are the metal electrodes for impressing driver voltage. In order that a metal electrode 14 may act a protection-from-light object, it forms only the center section of the luminous layer section main front face in a wrap form, and he is trying to take out light from the electrode agenesis field of the perimeter here.
[0004] In this case, since area of the leak light appearance field formed in the perimeter of an electrode 14 can be enlarged, the way which made area of a metal electrode 14 as small as possible is advantageous in the viewpoint whi raises optical drawing effectiveness. although the attempt to which extend a current effectively in a component and t amount of optical fetch is made to increase by the device of an electrode configuration is made conventionally, make increase of an electrode surface product into any also in this case -- it was hard to avoid and has lapsed into the dilemma to which the amount of optical fetch is restricted on the contrary by reduction of a leak light labor attendant product. Moreover, in order, as for conductivity, to optimize the radiative recombination of the carrier within a barrie layer 5, some are stopped by slight lowness, and as for dopant concentration ****** of a cladding layer 6, there is [a current] a pile inclination in field inboard at breadth. Current density concentrates on an electrode covering field, an this leads to the substantial amount of optical fetch in a leak light appearance field falling. Then, the approach of forming the current diffusion layer 107 of low resistivity which raised dopant concentration between a cladding laye and an electrode 14 is adopted. Conventionally, as the quality of the material of such a current diffusion layer 107, AlGaAs mixed crystal is used, for example.
[0005] Since lattice matching of the current diffusion layer 107 which consists of AlGaAs mixed crystal is carried ou to AlGaInP mixed crystal, there is an advantage which can carry out consistent growth as a semi-conductor layer of high quality in a growth furnace, but in order to equalize current density distribution of field inboard completely, as shown in drawing 7 (b), Thickness b must be set up quite thickly with about 50 micrometers. However, now, since a of raw materials are needed while time amount required for membrane formation becomes long, while productivity falls remarkably, it serves as high cost-ization and poses a big problem on industrial use. Moreover, the distance from the component front face to the barrier layer 5 which actually emits light became large too much, and the fault the operating characteristic in a RF is spoiled by series resistance increase in addition to luminous efficiency falling was also produced. On the other hand, as shown in drawing 7 (c), when thickness b of the current diffusion layer 107 is made small, current spreading effects run short conversely and there is dilemma to which the substantial amount of optical fetch in a leak light appearance field becomes small.

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[0006] Then, the whole surface of the current diffusion layer 107 which consists of AlGaAs mixed crystal is covered the ITO (Indium Tin Oxide: indium oxide tin) transparence conductive layer of high conductivity, although thicknes of the current diffusion layer 107 is made small, sufficient current spreading effect is attained, and the proposal whic raises optical fetch effectiveness is made.

[0007]

[Problem(s) to be Solved by the Invention] However, when the transparence conductive layer which consists of ITO was formed on the current diffusion layer 107 which consists of AlGaAs mixed crystal according to the place which this invention persons examined, it turned out that the contact resistance of a transparence conductive layer and the current diffusion layer 107 tends to become high, and it is hard that it comes to avoid decline in the luminous efficien by series resistance increase.

[0008] It is by adopting the component structure which can make contact resistance of this electrode small to offer th light emitting device which can improve optical fetch effectiveness while an oxide transparent electrode layer is used for this invention as an electrode for a luminescence drive.

[0009]

[Means for Solving the Problem and its Function and Effect] In order to solve the above-mentioned technical problem the first configuration of the light emitting device of this invention In the light emitting device which has the lumino layer section which consists of a compound semiconductor layer, and an oxide transparent electrode layer for impressing luminescence driver voltage to this luminous layer section, and took out the light from the luminous laye section in the form where an oxide transparent electrode layer is made to penetrate It is characterized by coming to form the electrode junctional zone which aluminum is not contained in the form which touches this oxide transparen electrode layer, and bandgap energy becomes from a compound semiconductor smaller than 1.42eV between the luminous layer section and an oxide transparent electrode layer.

[0010] According to the above-mentioned configuration, by using an oxide transparent electrode layer, it becomes possible to diffuse a current all over a light emitting device field effectively, without using a current diffusion layer, and it becomes possible to increase the amount of luminescence. Moreover, it becomes possible [the field covered w the metal electrode of protection-from-light nature] to design a wire in the magnitude at its minimum for carrying ou bonding (association), and in order to extend a current effectively in a light emitting device, an optical fetch area can made to increase as compared with the conventional light emitting device structure where the size of an electrode wa designed greatly. Furthermore, between the luminous layer section and an oxide transparent electrode layer, by form the electrode junctional zone which aluminum is not contained and bandgap energy becomes from a compound semiconductor smaller than 1.42eV, the contact resistance of an oxide transparent electrode layer can be decreased sharply, as a result optical fetch effectiveness can be raised in the form which touches this oxide transparent electrod layer.

[0011] By using the above electrode junctional zones, this invention persons consider the following two reasons as a reason for the ability to reduce the contact resistance of an oxide transparent electrode layer. ** Although the oxide transparent electrode layer was formed in the conventional light emitting device in the form which touches an AlGaA current diffusion layer, in order to fully secure the translucency of a current diffusion layer, it must be in slight considerable height about an AlAs mixed-crystal ratio. However, since the AlGaAs mixed crystal of a high AlAs mixed-crystal ratio contains aluminum in high concentration, if it is very easy to oxidize and an oxide transparent electrode layer is formed, the oxygen contained in this layer will combine with aluminum component in an AlGaAs current diffusion layer, and the oxidizing zone of high resistivity will be formed. ** Although the AlGaAs mixed crystal of a quantity AlAs mixed-crystal ratio is based also on a mixed-crystal ratio, since bandgap energy is as high 2.02-2.13eV, in what is usually used as a current diffusion layer, ohmic contact or the contact (for example, 10 to 4 o less ohm-cm: henceforth [these are named generically and] ohmic ******) of low resistivity near it is hard to be formed between oxide transparent electrode layers. Moreover, since bandgap energy contains aluminum highly with 2.3-2.35eV also when a direct oxide transparent electrode layer is contacted on an AlGaInP cladding layer, without using AlGaAs, the same problem as the case of Above AlGaAs arises.

[0012] According to the light emitting device of the configuration of the first of this invention, since the electrode junctional zone which touches an oxide transparent electrode layer does not contain aluminum, the oxidizing zone of high resistivity is hard to be formed, and can realize ohmic ****** easily by one also with small (it is 0.75eV when less than [1.42eV];, for example, In0.5Ga0.5As, is adopted) bandgap energy. Consequently, the contact resistance o transparent electrode layer can be reduced sharply.

[0013] Moreover, the luminous layer section which the second configuration of the light emitting device of this invention becomes from a compound semiconductor layer, In the light emitting device which has an oxide transparen

electrode layer for impressing luminescence driver voltage to this luminous layer section, and took out the light from the luminous layer section in the form where an oxide transparent electrode layer is made to penetrate It is characterized by coming to form the electrode junctional zone which consists of InxGa1-xAs (0< x<=1) in the form which touches this oxide transparent electrode layer between the luminous layer section and an oxide transparent electrode layer. Since this configuration is also using the oxide transparent electrode layer, an optical fetch area can b made to increase like the first configuration. Moreover, by forming the electrode junctional zone which consists of InxGa1-xAs between the luminous layer section and an oxide transparent electrode layer, the contact resistance of an oxide transparent electrode layer can be decreased sharply, as a result optical fetch effectiveness can be raised by lea and bounds.

[0014] Drawing 9 is the light emitting device in which the direct ITO transparent electrode was formed on the :**AlGaAs layer or the AlGaInP layer.;

** Light emitting device of light emitting device; which formed the ITO transparent electrode layer through the GaA layer (band gap 1.42eV) on AlGaAs, and this invention which formed the ITO transparent electrode layer through th **In0.5Ga0.5As electrode junctional zone;

** and each current potential property are shown. Although VF value (value of an electrical potential difference required to pass a certain specific current value) is falling to an ITO transparent electrode layer by the fall of a series resistance component in ** to which the GaAs layer was contacted as compared with **, the somewhat higher value still shown. On the other hand, in ** (this invention) using an InGaAs layer with bandgap energy smaller than GaAs the fall of VF is more remarkable and it turns out that practical level is reached.

[0015] In the first of the light emitting device of above-mentioned this invention, and the second configuration, what makes a subject the tin oxide (SnO2) or indium oxide (In 2O3) can be used for the quality of the material of an oxide transparent electrode layer. ITO is high conductivity and, specifically, can use an oxide transparent electrode layer suitable for this invention. ITO is the indium oxide film which doped the tin oxide, and can make the resistivity of an electrode layer the sufficiently low value of 5x10 to 4 or less ohm-cm by making the content of the tin oxide into one 9 mass %. In addition, except an ITO electrode layer, a ZnO electrode layer is high conductivity and can adopt it as t invention. the tin oxide (the so-called Nesa) which doped antimony oxide and Cd2 -- SnO4 and Zn2 -- SnO4, ZnSnO MgIn 2O4, CdSb 2O6 that doped yttrium oxide (Y), GaInO3 which doped the tin oxide can be used as the quality of the material of an oxide transparent electrode layer. [moreover,]

[0016] These oxide transparent electrode layers can be formed in physical vapor deposition (physical vapor deposition:PVD), such as the well-known gaseous-phase forming-membranes method (chemicalvapor deposition:CVD), for example, chemical vapor deposition, or sputtering, and vacuum deposition, or molecular beam epitaxy (molecularbeam epitaxy:MBE). For example, an ITO electrode layer and a ZnO electrode layer can be manufactured with RF sputtering or vacuum deposition, and a Nesa membrane can be manufactured with a CVD method. Moreover, it may replace with these vapor growth and you may form using other approaches, such as a sol-method.

[0017] An oxide transparent electrode layer can be formed in the form which covers the whole surface of the lumino layer section. Thus, since the thickness can be sharply reduced even when formation of the thick current diffusion lay which an oxide transparent electrode layer can be made to bear the function of a current diffusion layer if constituted and consists of a compound semiconductor like before becomes unnecessary or it forms temporarily, it contributes to the cost reduction by simplification of a process, and is very effective on industrial use. On the other hand, if it is the case where InxGa1-xAs is used, and the compound semiconductor which does not have to make it so thick and specifically constitutes an electrode junctional zone if it is sufficient extent which needs the formation thickness of a electrode junctional zone in order to form ohmic contact has about 0.001 micrometers, it is [that what is necessary is just to secure the thickness of extent which does not come to show the bandgap energy from which a bulk crystal differs by lamination] enough. Therefore, the distance between layers of an oxide transparent electrode layer and the luminous layer section can be contracted more sharply than the conventional light emitting device, and it becomes possible to fall the series resistance reduction effectiveness by it to the minimum. In addition, since decline in optica fetch effectiveness is caused as a result of the increase of light absorption in this electrode junctional zone, as for enlarging superfluously electrode junction layer thickness which consists of InxGa1-xAs, it is desirable to be referre to as 0.02 micrometers or less.

[0018] Moreover, yIn(AlxGa 1-x)1-yP (however, 0<=x<=1, 0<=y<=1) or InxGayAl1-x-yN Since each luminous lay section which consists of (0<=x<=1, 0<=y<=1, x+y<=1) contains aluminum in almost all cases, [however,] Althoug the problem of oxidation degradation must be taken into consideration, there is an advantage as which this oxide transparent electrode layer can be operated also as passivation film to the luminous layer section containing Above

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aluminum by adopting a wrap configuration extensively in an oxide transparent electrode layer.
[0019] In addition, although it is the compound semiconductor with which the difference of a lattice constant with th compound semiconductor (or GaAs) which makes the above-mentioned luminous layer section depending on a mixe crystal ratio becomes large somewhat, since InxGa1-xAs can stop the effect of grid mismatching comparatively sma when forming as a thin layer with a thickness of about 0.001-0.02 micrometers, it can form an electrode junctional z using this compound semiconductor.
[0020] In addition, when forming the electrode junctional zone which touches an oxide transparent electrode layer directly using a compound semiconductor layer, it is desirable as above-mentioned to use a compound semiconducto with bandgap energy smaller than 1.42eV from the viewpoint which forms ohmic ****** with this transparent electrode layer good. And it is also possible to use InP, InAs, GaSb, InSb(s), or those mixed crystal other than InGaA by effect mitigation of the grid mismatching by the above lamination.
[0021] (AlxGa 1-x) The first conductivity-type cladding layer, barrier layer, and the second conductivity-type claddi layer which consist of yIn1-yP or InxGayAl1-x-yN respectively (AlxGa 1-x) can form the luminous layer section which consists of yIn1-yP or InxGayAl1-x-yN in the double by which the laminating was carried out in this sequenc as what has terrorism structure. Since the hole and electron which were poured in are shut up into a narrow barrier la and recombine efficiently with the energy barrier resulting from a band gap difference with the cladding layer forme in the both sides of a barrier layer, very high luminous efficiency is realizable. Furthermore, the latter can realize respectively wide range luminescence wavelength applied to red (peak emission wavelength is 300nm or more 700n or less) from an ultraviolet region by presentation adjustment of a barrier layer, being able to apply the former to a re field (peak emission wavelength is 520nm or more 670nm or less) from green.
[0022] And an electrode junctional zone can be formed in the location of the first conductivity-type cladding layer an the second conductivity-type cladding layer which touches either at least in the above-mentioned configuration. For example, when using only the main front face of one side of the luminous layer section which consists of terrorism structure to double as an optical fetch side, an electrode junctional zone can be formed in the form which touches thi oxide transparent electrode between this cladding layer located in a side, and an oxide transparent electrode layer, an an oxide transparent electrode layer can be formed in it. On the other hand, when using the main front face of the bot sides of the luminous layer section as an optical fetch side, while forming an oxide transparent electrode correspondi to each of the cladding layer of both sides, between each oxide transparent electrode and a cladding layer, the electro junctional zone which touches an oxide transparent electrode can be formed.
[0023]
[Embodiment of the Invention] Hereafter, it explains with reference to the drawing of attachment of the gestalt of operation of this invention. Drawing 1 is the conceptual diagram showing the light emitting device 100 which is 1 operation gestalt of this invention. As for the light emitting device 100, the InGaAs layer 7 as an electrode junctional zone and the ITO electrode layer 8 as an oxide transparent electrode layer are formed in the first Lord front-face 17 s of the luminous layer section 24 in this sequence. Moreover, the InGaAs layer 9 as an electrode junctional zone and ITO electrode layer 10 as an oxide transparent electrode layer are formed in the second Lord front-face 18 side of the luminous layer section 24 in this sequence. the ITO electrode layers 8 and 10 -- the InGaAs layer 7 and the InGaAs layer 9 -- each of both the main front faces 17 and 18 of the luminous layer section 24 -- the whole surface is formed the wrap form.
[0024] The luminous layer section 24 is made into terrorism structure to the double which consists of a barrier layer located between the first conductivity-type cladding layer 6, the second conductivity-type cladding layer 4, and the f conductivity-type cladding layer 6 and the second conductivity-type cladding layer 4 while it is used as yIn1-yP mix crystal respectively (AlxGa 1-x). It has structure which specifically sandwiched the barrier layer 5 which consists of non dope (AlxGa 1-x) yIn1-yP (however, 0<=x<=0.55, 0.45<=y<=0.55) mixed crystal by the p mold (AlxGa 1-x) yI yP cladding layer 6 and the n mold (AlxGa 1-x) yIn1-yP cladding layer 4. In the light emitting device 100 of drawin 1 , the p mold AlGaInP cladding layer 6 is arranged at the ITO electrode layer 8 side, and the n mold AlGaInP cladd layer 4 is arranged at the ITO electrode layer 10 side. Therefore, the ITO electrode layer 8 side of an energization polarity is forward. In addition, although it is obvious to this contractor, a "non dope" here means "Positive addition a dopant is not performed", and content (for example, let about three 1013-1016-/cm be an upper limit) of the dopant component mixed unescapable is not eliminated on the usual production process, either.
[0025] In addition, : which can illustrate the following numeric values as an example of the thickness of each class in the light emitting device 100 of drawing 1 , InGaAs layer 7= thickness:micrometer-ITO [about 0.005] electrode lay 8= thickness: 0.2 micrometers, tin-oxide content:7 mass % (remainder indium oxide);
- 6= 1 micrometer of p mold AlGaInP cladding layers;

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- 5= 0.6 micrometers of AlGaInP barrier layers;
- 4= 1 micrometer of n mold AlGaInP cladding layers;
- InGaAs layer 9= thickness : the same configuration as the about 0.005 micrometer-ITO electrode layer 10=ITO electrode layer 8.

[0026] Hereafter, the manufacture approach of the light emitting device 100 of drawing 1 is explained. As shown in drawing 3 , the n mold GaAs buffer layer 2 0.5 micrometers, for example to first Lord surface 1a of the GaAs single crystal substrate 1 which is a compound semiconductor single crystal substrate which carries out lattice matching to AlGaInP mixed crystal first, subsequently As the luminous layer section 24 The AlGaInP barrier layer (non dope) 5 4 or 0.6 micrometers of 1 micrometer of n mold AlGaInP cladding layers and the 1-micrometer p mold AlGaInP cladding layer 6, and a pan are made to carry out epitaxial growth of the InGaAs layer 7 in 0.005 micrometers in thickness on the p mold AlGaInP cladding layer 6. organic metal vapor phase epitaxial growth (Metalorganic Vapor Phase Epitaxy:MOVPE) with the well-known epitaxial growth of these each class -- it can carry out by law.

[0027] Etching removal of the GaAs substrate 1 and the GaAs buffer layer 2 can be carried out by being immersed in after the above-mentioned growth (for example, the etching reagent which consists of a sulfuric-acid system water solution (30% hydrogen peroxide solution: concentrated sulfuric acid : water = 3:1:1 capacity factors)) (drawing 4 (and it is shown in this drawing (b) -- as -- it the side by which etching exfoliation was carried out -- setting -- the ma front face 18 of the n mold AlGaInP cladding layer 4 -- the InGaAs layer 9 -- MOVPE -- epitaxial growth is carried in 0.005 micrometers in thickness by law.

[0028] And on both the main front face of each InGaAs layer 7 and the InGaAs layer 9, by the well-known RF-sputtering method (a target presentation (In2O3=90.2 % of the weight, 2= 9.8 % of the weight of SnO(s)), rf frequen of 13.56MHz, Ar pressure of 0.6Pa, spatter power 30W), the ITO electrode layers 8 and 10 are formed in 0.2 micrometers in thickness, respectively, and the layered product wafer 13 is obtained. In addition, figure resistivity single [about] can be reduced by heat-treating at the temperature of 300 degrees C - 500 degrees C among nitrogen-gas-atmosphere mind after film formation. After the layered product wafer's 13 being used as a semiconductor chip b dicing and fixing to a base material, as shown in drawing 1 , lead wire 14b and 15b is attached, and a light emitting device 100 is obtained by forming the resin seal section which is not illustrated further.

[0029] According to the above-mentioned light emitting device 100, the ITO electrode layer 8 and the ITO electrode layer 10 come to cover the whole surface of the p mold AlGaInP cladding layer 6 and the n mold AlGaInP cladding layer 4 through the InGaAs layer 7 and the InGaAs layer 9, respectively, and driver voltage is impressed through the ITO(s) electrode layers 8 and 10. Since the electrode layers 8 and 10 are transparence, optical fetch effectiveness of t drive current by driver voltage improves, while uniform luminescence is obtained covering the optical whole fetch si (both main front faces 17 and 18), since it is spread in homogeneity all over the conductive good ITO electrode layer and 10. Furthermore, in order to form an ohmic ****** condition to the InGaAs layer 7 with a comparatively narrow band gap, and the InGaAs layer 9, the series resistance of the contact section is stopped small and, as for the ITO electrode layers 8 and 10, luminous efficiency is raised sharply.

[0030] Furthermore, since a thick current diffusion layer like the conventional light emitting device becomes unnecessary, distance to an ITO electrode layer (oxide transparent electrode layer) and a luminescence side can be shortened sharply. Consequently, reduction of series resistance can be aimed at. In addition, a luminescence side is defined as follows. First, when the luminous layer section 24 has terrorism structure to the above double, the claddin layer / barrier layer interface (if it sees from the ITO electrode layer 8, it will be p mold cladding layer 6, a barrier lay 5, and an interface, and if it sees from the ITO electrode layer 10, they will be n mold cladding layer 4, a barrier laye and an interface) of the side near an oxide transparent electrode layer (ITO electrode layer) are defined as a luminescence side. On the other hand, although this invention is applicable not only to what has the luminous layer section of a terrorism structured type to the above double but the light emitting device which has the light-emitting p of a terrorism structured type to a single, it defines that heterojunction interface as a luminescence side in this case. A the distance t from the interface of an oxide transparent electrode layer and an electrode junctional zone to a luminescence side (refer to drawing 1) specifically becomes possible [considering as the small value of 3 micromet or less] by adoption of this invention.

[0031] The InGaAs layer 7 or the InGaAs layer 9 which is an electrode junctional zone Although you may form as what has the respectively same conductivity type as each cladding layers 6 and 4 which touch this by addition of a suitable dopant When forming the InGaAs layer 7 or the InGaAs layer 9 as above thin layers It is a low dope layer w low dopant concentration (for example, since too much increment in series resistance is not caused even if it forms a less than [1017 piece //cm / 3]; or a non dope layer (1013 piece/cm3-1016 piece/cm3), it is employable satisfactory about these. On the other hand, when it considers as a low dope layer, the following effectiveness can be attained

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depending on the driver voltage of a light emitting device. That is, the electric field (namely, electrical potential difference per unit distance) impressed in the direction of thickness of an electrode junctional zone by using an electrode junctional zone as a low dope layer to the small cladding layer or ITO layer of electrical resistivity which sandwiches this since the electrical resistivity of a layer itself becomes high become high relatively. If the electrode junctional zone is formed by comparatively small InGaAs of a band gap at this time, moderate deflection arises in th band structure of an electrode junctional zone by impression of the above-mentioned electric field, and better ohmic ****** can be formed.

[0032] In addition, when an InGaAs layer and an AlGaInP layer are joined directly, a little high hetero obstruction is formed in a junction interface, it originates in this, and a series resistance component may increase. Then, the interlay who consists of the GaAs layer 19, an AlGaAs layer 20, and AlGaInP layer 21 grade can be inserted like the light emitting device 150 shown in drawing 8 if needed between the InGaAs electrode junctional zone 7 which touches th oxide transparent electrode (ITO electrode layer) 8, and the AlGaInP cladding layer 6 in order to reduce this. Since compaction of the epitaxial growth time amount by lamination, as a result improvement in productivity can be aimed since these interlayers' thickness can be respectively referred to as about 0.1 micrometers or less and the increment o the series resistance by interlayer formation can also be lessened even when adopting this structure, luminous efficiency is also hard to be spoiled.

[0033] In addition, an electrode junctional zone (for example, InGaAs layer) and an oxide transparent electrode layer (ITO electrode layer) may be joined to the luminous layer section 24 which consists of a terrorism structure layer to double only at the one side like the light emitting device 50 shown in drawing 5 . In this case, the n mold GaAs substrate 1 is diverted to a component substrate, and the InGaAs layer 7 and the ITO electrode layer 8 are formed in that first Lord front-face side. moreover, the semi-conductor multilayers currently indicated by JP,7-66455,A betwee the GaAs substrate 1 and the luminous layer section 24 like the light emitting device 51 shown in drawing 6 -- or the metal layer which consisted of Au thru/or an Au alloy can be inserted as a reflecting layer 16. Since reflected light L a reflecting layer 16 is added from the luminous layer section 24 by this in addition to the light L leaked to a direct li fetch layer side, optical fetch effectiveness can be raised. Moreover, in order to reduce total reflection loss further, th interface of the luminous layer section and an optical fetch layer can be turned in the optical fetch direction, and it ca also incurvate convex as indicated by JP,5-190893,A.

[0034] In the light emitting device 100 of drawing 1 , although each class of the luminous layer section 24 which makes terrorism structure to double was formed with AlGaInP mixed crystal, as shown in drawing 2 , blue or the wid gap mold light emitting device 200 for ultraviolet luminescence can also be constituted by forming in double each cl (p mold cladding layer 106, a barrier layer 105, and n mold cladding layer 104) of the luminous layer section 124 which makes terrorism structure with AlGaInN mixed crystal. the luminous layer section 124 -- the light emitting device 100 of drawing 1 -- the same -- MOVPE -- it is formed of law. Except for the luminous layer section 124, sin the remaining part is the same configuration as the light emitting device 100 of drawing 1 , the light emitting device 200 of this drawing 2 omits detailed explanation.

[0035] Moreover, a barrier layer 5 or 105 can also be constituted as that to which the laminating of two or more compound semiconductor layers from which bandgap energy differs was carried out in this, and a thing which specifically has quantum well structure as shown in drawing 10 (a), although formed as a monolayer with the above-mentioned operation gestalt. As shown in drawing 10 (b) and (c), the laminating of the barrier layer which has quant well structure is carried out in the form to which lattice matching of two-layer [two-layer / B / a band gap is mutuall different from with adjustment of a mixed-crystal ratio], i.e., the small well layer of bandgap energy, and the large barrier layer A is carried out so that it may become an electronic average free process or the thickness not more than (generally one atomic layer - 10A of numbers) respectively. With the above-mentioned structure, since the energy of the electron (or hole) of the well layer B is quantized, for example, when it applies to semiconductor laser etc., the width of face and the depth of an energy well layer can adjust oscillation wavelength freely, and there is effectivenes in stabilization of oscillation wavelength, improvement in luminous efficiency, the reduction that is oscillation threshold current density further. Furthermore, since thickness is very small, if the well layer B and a barrier layer A are to about 2 - 3%, a gap of a lattice constant is permitted and expansion of an oscillation wavelength field is also ea for them. In addition, quantum well structure may be good also as multiplex quantum well structure of having two or more well layers B, and as shown in (c), any are sufficient as it, as shown in (b) also as single quantum well structure having one layer of well layers B. drawing -- with 0.5(aluminum0.7Ga0.3) In0.5P mixed crystal, 0.5 (aluminum0.5Ga0.5) In0.5P mixed crystal constitutes a barrier layer A, and 0.5(aluminum0.2Ga0.8) In0.5P mixed crystal constitutes the well layer B for each cladding layer of p mold and n mold, respectively. In addition, the thickness of a barrier layer A can make only what touches a cladding layer about 500A, and others can be made into

about 60A. Moreover, the well layer B can be made into about 50A.

[0036] As mentioned above, although the gestalt of operation of this invention was shown, this invention can add various amelioration or modification, unless it is not limited to this at all and deviates from the items mentioned of a claim. For example, with the above-mentioned operation gestalt, although the luminous layer section was formed wi AlGaInP mixed crystal or AlGaInN mixed crystal, GaP, GaAsP, or AlGaAs may form the luminous layer section wi other compound semiconductors, and the effectiveness of this invention described above also in this case can be attained.

[Translation done.]

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* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

TECHNICAL FIELD

[Field of the Invention] This invention relates to a light emitting device.

[Translation done.]

PRIOR ART

[Description of the Prior Art] (AlxGa 1-x) yIn1-yP (however, the light emitting device in which the luminous layer section was formed with 0<=x<=1 and 0<=y<=1 (following and AlGaInP mixed crystal -- or it is only indicated also AlGaInP) mixed crystal can realize the component of high brightness by adopting terrorism structure to the double which sandwiched the thin AlGaInP barrier layer in the shape of sandwiches by the n mold AlGaInP cladding layer with a larger band gap than it, and the p mold AlGaInP cladding layer.) Moreover, in recent years, the blue light emitting device which formed terrorism structure in the same double using InxGayAl1-x-yN (however, 0<=x<=1, 0<=y<=1, x+y<=1) is also put in practical use.

[0003] For example, drawing 7 (a) is the example of an AlGaInP light emitting device, in this component 300, in the form which carries out heteroepitaxial growth on the n mold GaAs substrate 1, the laminating of the n mold GaAs buffer layer 2, the n mold AlGaInP cladding layer 4, the AlGaInP barrier layer 5, and the p mold AlGaInP cladding layer 6 is carried out in this sequence, and the luminous layer section 24 which makes terrorism structure to double i formed. 14 and 15 are the metal electrodes for impressing driver voltage. In order that a metal electrode 14 may act a protection-from-light object, it forms only the center section of the luminous layer section main front face in a wrap form, and he is trying to take out light from the electrode agenesis field of the perimeter here.

[0004] In this case, since area of the leak light appearance field formed in the perimeter of an electrode 14 can be enlarged, the way which made area of a metal electrode 14 as small as possible is advantageous in the viewpoint whi raises optical drawing effectiveness. although the attempt to which extend a current effectively in a component and t amount of optical fetch is made to increase by the device of an electrode configuration is made conventionally, make increase of an electrode surface product into any also in this case -- it was hard to avoid and has lapsed into the dilemma to which the amount of optical fetch is restricted on the contrary by reduction of a leak light labor attendant product. Moreover, in order, as for conductivity, to optimize the radiative recombination of the carrier within a barrie layer 5, some are stopped by slight lowness, and as for dopant concentration ****** of a cladding layer 6, there is [a current] a pile inclination in field inboard at breadth. Current density concentrates on an electrode covering field, an this leads to the substantial amount of optical fetch in a leak light appearance field falling. Then, the approach of forming the current diffusion layer 107 of low resistivity which raised dopant concentration between a cladding laye and an electrode 14 is adopted. Conventionally, as the quality of the material of such a current diffusion layer 107, AlGaAs mixed crystal is used, for example.

[0005] Since lattice matching of the current diffusion layer 107 which consists of AlGaAs mixed crystal is carried ou to AlGaInP mixed crystal, there is an advantage which can carry out consistent growth as a semi-conductor layer of high quality in a growth furnace, but in order to equalize current density distribution of field inboard completely, as shown in drawing 7 (b), Thickness b must be set up quite thickly with about 50 micrometers. However, now, since a of raw materials are needed while time amount required for membrane formation becomes long, while productivity falls remarkably, it serves as high cost-ization and poses a big problem on industrial use. Moreover, the distance from the component front face to the barrier layer 5 which actually emits light became large too much, and the fault the operating characteristic in a RF is spoiled by series resistance increase in addition to luminous efficiency falling was also produced. On the other hand, as shown in drawing 7 (c), when thickness b of the current diffusion layer 107 is made small, current spreading effects run short conversely and there is dilemma to which the substantial amount of optical fetch in a leak light appearance field becomes small.

[0006] Then, the whole surface of the current diffusion layer 107 which consists of AlGaAs mixed crystal is covered the ITO (Indium Tin Oxide: indium oxide tin) transparence conductive layer of high conductivity, although thicknes of the current diffusion layer 107 is made small, sufficient current spreading effect is attained, and the proposal whic raises optical fetch effectiveness is made.

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[Translation done.]

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EFFECT OF THE INVENTION

[Means for Solving the Problem and its Function and Effect] In order to solve the above-mentioned technical problem the first configuration of the light emitting device of this invention In the light emitting device which has the lumino layer section which consists of a compound semiconductor layer, and an oxide transparent electrode layer for impressing luminescence driver voltage to this luminous layer section, and took out the light from the luminous laye section in the form where an oxide transparent electrode layer is made to penetrate It is characterized by coming to form the electrode junctional zone which aluminum is not contained in the form which touches this oxide transparen electrode layer, and bandgap energy becomes from a compound semiconductor smaller than 1.42eV between the luminous layer section and an oxide transparent electrode layer.

[0010] According to the above-mentioned configuration, by using an oxide transparent electrode layer, it becomes possible to diffuse a current all over a light emitting device field effectively, without using a current diffusion layer, and it becomes possible to increase the amount of luminescence. Moreover, it becomes possible [the field covered w the metal electrode of protection-from-light nature] to design a wire in the magnitude at its minimum for carrying ou bonding (association), and in order to extend a current effectively in a light emitting device, an optical fetch area can made to increase as compared with the conventional light emitting device structure where the size of an electrode wa designed greatly. Furthermore, between the luminous layer section and an oxide transparent electrode layer, by form the electrode junctional zone which aluminum is not contained and bandgap energy becomes from a compound semiconductor smaller than 1.42eV, the contact resistance of an oxide transparent electrode layer can be decreased sharply, as a result optical fetch effectiveness can be raised in the form which touches this oxide transparent electrod layer.

[0011] By using the above electrode junctional zones, this invention persons consider the following two reasons as a reason for the ability to reduce the contact resistance of an oxide transparent electrode layer. ** Although the oxide transparent electrode layer was formed in the conventional light emitting device in the form which touches an AlGaA current diffusion layer, in order to fully secure the translucency of a current diffusion layer, it must be in slight considerable height about an AlAs mixed-crystal ratio. However, since the AlGaAs mixed crystal of a high AlAs mixed-crystal ratio contains aluminum in high concentration, if it is very easy to oxidize and an oxide transparent electrode layer is formed, the oxygen contained in this layer will combine with aluminum component in an AlGaAs current diffusion layer, and the oxidizing zone of high resistivity will be formed. ** Although the AlGaAs mixed crystal of a quantity AlAs mixed-crystal ratio is based also on a mixed-crystal ratio, since bandgap energy is as high 2.02-2.13eV, in what is usually used as a current diffusion layer, ohmic contact or the contact (for example, 10 to 4 o less ohm-cm: henceforth [these are named generically and] ohmic ******) of low resistivity near it is hard to be formed between oxide transparent electrode layers. Moreover, since bandgap energy contains aluminum highly with 2.3-2.35eV also when a direct oxide transparent electrode layer is contacted on an AlGaInP cladding layer, without using AlGaAs, the same problem as the case of Above AlGaAs arises.

[0012] According to the light emitting device of the configuration of the first of this invention, since the electrode junctional zone which touches an oxide transparent electrode layer does not contain aluminum, the oxidizing zone of high resistivity is hard to be formed, and can realize ohmic ****** easily by one also with small (it is 0.75eV when less than [1.42eV];, for example, In0.5Ga0.5As, is adopted) bandgap energy. Consequently, the contact resistance o transparent electrode layer can be reduced sharply.

[0013] Moreover, the luminous layer section which the second configuration of the light emitting device of this invention becomes from a compound semiconductor layer, In the light emitting device which has an oxide transparen electrode layer for impressing luminescence driver voltage to this luminous layer section, and took out the light from the luminous layer section in the form where an oxide transparent electrode layer is made to penetrate It is

characterized by coming to form the electrode junctional zone which consists of InxGa1-xAs (0< x<=1) in the form which touches this oxide transparent electrode layer between the luminous layer section and an oxide transparent electrode layer. Since this configuration is also using the oxide transparent electrode layer, an optical fetch area can b made to increase like the first configuration. Moreover, by forming the electrode junctional zone which consists of InxGa1-xAs between the luminous layer section and an oxide transparent electrode layer, the contact resistance of an oxide transparent electrode layer can be decreased sharply, as a result optical fetch effectiveness can be raised by lea and bounds.

[0014] Drawing 9 is the light emitting device in which the direct ITO transparent electrode was formed on the :**AlGaAs layer or the AlGaInP layer.;

** Light emitting device of light emitting device; which formed the ITO transparent electrode layer through the GaA layer (band gap 1.42eV) on AlGaAs, and this invention which formed the ITO transparent electrode layer through th **In0.5Ga0.5As electrode junctional zone;

** and each current potential property are shown. Although VF value (value of an electrical potential difference required to pass a certain specific current value) is falling to an ITO transparent electrode layer by the fall of a series resistance component in ** to which the GaAs layer was contacted as compared with **, the somewhat higher value still shown. On the other hand, in ** (this invention) using an InGaAs layer with bandgap energy smaller than GaAs the fall of VF is more remarkable and it turns out that practical level is reached.

[0015] In the first of the light emitting device of above-mentioned this invention, and the second configuration, what makes a subject the tin oxide (SnO2) or indium oxide (In 2O3) can be used for the quality of the material of an oxide transparent electrode layer. ITO is high conductivity and, specifically, can use an oxide transparent electrode layer suitable for this invention. ITO is the indium oxide film which doped the tin oxide, and can make the resistivity of an electrode layer the sufficiently low value of 5x10 to 4 or less ohm-cm by making the content of the tin oxide into one 9 mass %. In addition, except an ITO electrode layer, a ZnO electrode layer is high conductivity and can adopt it as t invention. the tin oxide (the so-called Nesa) which doped antimony oxide and Cd2 -- SnO4 and Zn2 -- SnO4, ZnSnO MgIn 2O4, CdSb 2O6 that doped yttrium oxide (Y), GaInO3 which doped the tin oxide can be used as the quality of the material of an oxide transparent electrode layer. [moreover,]

[0016] These oxide transparent electrode layers can be formed in physical vapor deposition (physical vapor deposition:PVD), such as the well-known gaseous-phase forming-membranes method (chemicalvapor deposition:CVD), for example, chemical vapor deposition, or sputtering, and vacuum deposition, or molecular beam epitaxy (molecularbeam epitaxy:MBE). For example, an ITO electrode layer and a ZnO electrode layer can be manufactured with RF sputtering or vacuum deposition, and a Nesa membrane can be manufactured with a CVD method. Moreover, it may replace with these vapor growth and you may form using other approaches, such as a sol- method.

[0017] An oxide transparent electrode layer can be formed in the form which covers the whole surface of the lumino layer section. Thus, since the thickness can be sharply reduced even when formation of the thick current diffusion lay which an oxide transparent electrode layer can be made to bear the function of a current diffusion layer if constituted and consists of a compound semiconductor like before becomes unnecessary or it forms temporarily, it contributes to the cost reduction by simplification of a process, and is very effective on industrial use. On the other hand, if it is the case where InxGa1-xAs is used, and the compound semiconductor which does not have to make it so thick and specifically constitutes an electrode junctional zone if it is sufficient extent which needs the formation thickness of a electrode junctional zone in order to form ohmic contact has about 0.001 micrometers, it is [that what is necessary is just to secure the thickness of extent which does not come to show the bandgap energy from which a bulk crystal differs by lamination] enough. Therefore, the distance between layers of an oxide transparent electrode layer and the luminous layer section can be contracted more sharply than the conventional light emitting device, and it becomes possible to fall the series resistance reduction effectiveness by it to the minimum. In addition, since decline in optica fetch effectiveness is caused as a result of the increase of light absorption in this electrode junctional zone, as for enlarging superfluously electrode junction layer thickness which consists of InxGa1-xAs, it is desirable to be referre to as 0.02 micrometers or less.

[0018] Moreover, yIn(AlxGa 1-x)1-yP (however, 0<=x<=1, 0<=y<=1) or InxGayAl1-x-yN Since each luminous lay section which consists of (0<=x<=1, 0<=y<=1, x+y<=1) contains aluminum in almost all cases, [however,] Althoug the problem of oxidation degradation must be taken into consideration, there is an advantage as which this oxide transparent electrode layer can be operated also as passivation film to the luminous layer section containing Above aluminum by adopting a wrap configuration extensively in an oxide transparent electrode layer.

[0019] In addition, although it is the compound semiconductor with which the difference of a lattice constant with th

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compound semiconductor (or GaAs) which makes the above-mentioned luminous layer section depending on a mixe crystal ratio becomes large somewhat, since InxGa1-xAs can stop the effect of grid mismatching comparatively sma when forming as a thin layer with a thickness of about 0.001-0.02 micrometers, it can form an electrode junctional z using this compound semiconductor.

[0020] In addition, when forming the electrode junctional zone which touches an oxide transparent electrode layer directly using a compound semiconductor layer, it is desirable as above-mentioned to use a compound semiconducto with bandgap energy smaller than 1.42eV from the viewpoint which forms ohmic ****** with this transparent electrode layer good. And it is also possible to use InP, InAs, GaSb, InSb(s), or those mixed crystal other than InGaA by effect mitigation of the grid mismatching by the above lamination.

[0021] (AlxGa 1-x) The first conductivity-type cladding layer, barrier layer, and the second conductivity-type claddi layer which consist of yIn1-yP or InxGayAl1-x-yN respectively (AlxGa 1-x) can form the luminous layer section which consists of yIn1-yP or InxGayAl1-x-yN in the double by which the laminating was carried out in this sequenc as what has terrorism structure. Since the hole and electron which were poured in are shut up into a narrow barrier la and recombine efficiently with the energy barrier resulting from a band gap difference with the cladding layer forme in the both sides of a barrier layer, very high luminous efficiency is realizable. Furthermore, the latter can realize respectively wide range luminescence wavelength applied to red (peak emission wavelength is 300nm or more 700n or less) from an ultraviolet region by presentation adjustment of a barrier layer, being able to apply the former to a re field (peak emission wavelength is 520nm or more 670nm or less) from green.

[0022] And an electrode junctional zone can be formed in the location of the first conductivity-type cladding layer an the second conductivity-type cladding layer which touches either at least in the above-mentioned configuration. For example, when using only the main front face of one side of the luminous layer section which consists of terrorism structure to double as an optical fetch side, an electrode junctional zone can be formed in the form which touches thi oxide transparent electrode between this cladding layer located in a side, and an oxide transparent electrode layer, an an oxide transparent electrode layer can be formed in it. On the other hand, when using the main front face of the bot sides of the luminous layer section as an optical fetch side, while forming an oxide transparent electrode correspondi to each of the cladding layer of both sides, between each oxide transparent electrode and a cladding layer, the electro junctional zone which touches an oxide transparent electrode can be formed.

[0023]

[Embodiment of the Invention] Hereafter, it explains with reference to the drawing of attachment of the gestalt of operation of this invention. Drawing 1 is the conceptual diagram showing the light emitting device 100 which is 1 operation gestalt of this invention. As for the light emitting device 100, the InGaAs layer 7 as an electrode junctional zone and the ITO electrode layer 8 as an oxide transparent electrode layer are formed in the first Lord front-face 17 s of the luminous layer section 24 in this sequence. Moreover, the InGaAs layer 9 as an electrode junctional zone and ITO electrode layer 10 as an oxide transparent electrode layer are formed in the second Lord front-face 18 side of the luminous layer section 24 in this sequence. the ITO electrode layers 8 and 10 -- the InGaAs layer 7 and the InGaAs layer 9 -- each of both the main front faces 17 and 18 of the luminous layer section 24 -- the whole surface is formed the wrap form.

[0024] The luminous layer section 24 is made into terrorism structure to the double which consists of a barrier layer located between the first conductivity-type cladding layer 6, the second conductivity-type cladding layer 4, and the f conductivity-type cladding layer 6 and the second conductivity-type cladding layer 4 while it is used as yIn1-yP mix crystal respectively (AlxGa 1-x). It has structure which specifically sandwiched the barrier layer 5 which consists of non dope (AlxGa 1-x) yIn1-yP (however, 0<=x<=0.55, 0.45<=y<=0.55) mixed crystal by the p mold (AlxGa 1-x) yI yP cladding layer 6 and the n mold (AlxGa 1-x) yIn1-yP cladding layer 4. In the light emitting device 100 of drawin 1 , the p mold AlGaInP cladding layer 6 is arranged at the ITO electrode layer 8 side, and the n mold AlGaInP cladd layer 4 is arranged at the ITO electrode layer 10 side. Therefore, the ITO electrode layer 8 side of an energization polarity is forward. In addition, although it is obvious to this contractor, a "non dope" here means "Positive addition a dopant is not performed", and content (for example, let about three 1013-1016-/cm be an upper limit) of the dopant component mixed unescapable is not eliminated on the usual production process, either.

[0025] In addition, : which can illustrate the following numeric values as an example of the thickness of each class in the light emitting device 100 of drawing 1 , InGaAs layer 7= thickness:micrometer-ITO [about 0.005] electrode lay 8= thickness: 0.2 micrometers, tin-oxide content:7 mass % (remainder indium oxide);

- 6= 1 micrometer of p mold AlGaInP cladding layers;
- 5= 0.6 micrometers of AlGaInP barrier layers;
- 4= 1 micrometer of n mold AlGaInP cladding layers;

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- InGaAs layer 9= thickness : the same configuration as the about 0.005 micrometer-ITO electrode layer 10=ITO electrode layer 8.

[0026] Hereafter, the manufacture approach of the light emitting device 100 of drawing 1 is explained. As shown in drawing 3 , the n mold GaAs buffer layer 2 0.5 micrometers, for example to first Lord surface 1a of the GaAs single crystal substrate 1 which is a compound semiconductor single crystal substrate which carries out lattice matching to AlGaInP mixed crystal first, subsequently As the luminous layer section 24 The AlGaInP barrier layer (non dope) 5 4 or 0.6 micrometers of 1 micrometer of n mold AlGaInP cladding layers and the 1-micrometer p mold AlGaInP cladding layer 6, and a pan are made to carry out epitaxial growth of the InGaAs layer 7 in 0.005 micrometers in thickness on the p mold AlGaInP cladding layer 6. organic metal vapor phase epitaxial growth (Metalorganic Vapor Phase Epitaxy:MOVPE) with the well-known epitaxial growth of these each class -- it can carry out by law.

[0027] Etching removal of the GaAs substrate 1 and the GaAs buffer layer 2 can be carried out by being immersed in after the above-mentioned growth (for example, the etching reagent which consists of a sulfuric-acid system water solution (30% hydrogen peroxide solution: concentrated sulfuric acid : water = 3:1:1 capacity factors)) (drawing 4 (and it is shown in this drawing (b) -- as -- it the side by which etching exfoliation was carried out -- setting -- the ma front face 18 of the n mold AlGaInP cladding layer 4 -- the InGaAs layer 9 -- MOVPE -- epitaxial growth is carried in 0.005 micrometers in thickness by law.

[0028] And on both the main front face of each InGaAs layer 7 and the InGaAs layer 9, by the well-known RF-sputtering method (a target presentation (In2O3=90.2 % of the weight, 2= 9.8 % of the weight of SnO(s)), rf frequen of 13.56MHz, Ar pressure of 0.6Pa, spatter power 30W), the ITO electrode layers 8 and 10 are formed in 0.2 micrometers in thickness, respectively, and the layered product wafer 13 is obtained. In addition, figure resistivity single [about] can be reduced by heat-treating at the temperature of 300 degrees C - 500 degrees C among nitrogen-gas-atmosphere mind after film formation. After the layered product wafer's 13 being used as a semiconductor chip b dicing and fixing to a base material, as shown in drawing 1 , lead wire 14b and 15b is attached, and a light emitting device 100 is obtained by forming the resin seal section which is not illustrated further.

[0029] According to the above-mentioned light emitting device 100, the ITO electrode layer 8 and the ITO electrode layer 10 come to cover the whole surface of the p mold AlGaInP cladding layer 6 and the n mold AlGaInP cladding layer 4 through the InGaAs layer 7 and the InGaAs layer 9, respectively, and driver voltage is impressed through the ITO(s) electrode layers 8 and 10. Since the electrode layers 8 and 10 are transparence, optical fetch effectiveness of t drive current by driver voltage improves, while uniform luminescence is obtained covering the optical whole fetch si (both main front faces 17 and 18), since it is spread in homogeneity all over the conductive good ITO electrode layer and 10. Furthermore, in order to form an ohmic ****** condition to the InGaAs layer 7 with a comparatively narrow band gap, and the InGaAs layer 9, the series resistance of the contact section is stopped small and, as for the ITO electrode layers 8 and 10, luminous efficiency is raised sharply.

[0030] Furthermore, since a thick current diffusion layer like the conventional light emitting device becomes unnecessary, distance to an ITO electrode layer (oxide transparent electrode layer) and a luminescence side can be shortened sharply. Consequently, reduction of series resistance can be aimed at. In addition, a luminescence side is defined as follows. First, when the luminous layer section 24 has terrorism structure to the above double, the claddin layer / barrier layer interface (if it sees from the ITO electrode layer 8, it will be p mold cladding layer 6, a barrier lay 5, and an interface, and if it sees from the ITO electrode layer 10, they will be n mold cladding layer 4, a barrier laye and an interface) of the side near an oxide transparent electrode layer (ITO electrode layer) are defined as a luminescence side. On the other hand, although this invention is applicable not only to what has the luminous layer section of a terrorism structured type to the above double but the light emitting device which has the light-emitting p of a terrorism structured type to a single, it defines that heterojunction interface as a luminescence side in this case. A the distance t from the interface of an oxide transparent electrode layer and an electrode junctional zone to a luminescence side (refer to drawing 1) specifically becomes possible [considering as the small value of 3 micromet or less] by adoption of this invention.

[0031] The InGaAs layer 7 or the InGaAs layer 9 which is an electrode junctional zone Although you may form as what has the respectively same conductivity type as each cladding layers 6 and 4 which touch this by addition of a suitable dopant When forming the InGaAs layer 7 or the InGaAs layer 9 as above thin layers It is a low dope layer w low dopant concentration (for example, since too much increment in series resistance is not caused even if it forms a less than [1017 piece //cm / 3]; or a non dope layer (1013 piece/cm3-1016 piece/cm3), it is employable satisfactory about these. On the other hand, when it considers as a low dope layer, the following effectiveness can be attained depending on the driver voltage of a light emitting device. That is, the electric field (namely, electrical potential difference per unit distance) impressed in the direction of thickness of an electrode junctional zone by using an

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electrode junctional zone as a low dope layer to the small cladding layer or ITO layer of electrical resistivity which sandwiches this since the electrical resistivity of a layer itself becomes high become high relatively. If the electrode junctional zone is formed by comparatively small InGaAs of a band gap at this time, moderate deflection arises in th band structure of an electrode junctional zone by impression of the above-mentioned electric field, and better ohmic ****** can be formed.

[0032] In addition, when an InGaAs layer and an AlGaInP layer are joined directly, a little high hetero obstruction is formed in a junction interface, it originates in this, and a series resistance component may increase. Then, the interlay who consists of the GaAs layer 19, an AlGaAs layer 20, and AlGaInP layer 21 grade can be inserted like the light emitting device 150 shown in drawing 8 if needed between the InGaAs electrode junctional zone 7 which touches th oxide transparent electrode (ITO electrode layer) 8, and the AlGaInP cladding layer 6 in order to reduce this. Since compaction of the epitaxial growth time amount by lamination, as a result improvement in productivity can be aimed since these interlayers' thickness can be respectively referred to as about 0.1 micrometers or less and the increment o the series resistance by interlayer formation can also be lessened even when adopting this structure, luminous efficiency is also hard to be spoiled.

[0033] In addition, an electrode junctional zone (for example, InGaAs layer) and an oxide transparent electrode layer (ITO electrode layer) may be joined to the luminous layer section 24 which consists of a terrorism structure layer to double only at the one side like the light emitting device 50 shown in drawing 5 . In this case, the n mold GaAs substrate 1 is diverted to a component substrate, and the InGaAs layer 7 and the ITO electrode layer 8 are formed in that first Lord front-face side. moreover, the semi-conductor multilayers currently indicated by JP,7-66455,A betwee the GaAs substrate 1 and the luminous layer section 24 like the light emitting device 51 shown in drawing 6 -- or the metal layer which consisted of Au thru/or an Au alloy can be inserted as a reflecting layer 16. Since reflected light L a reflecting layer 16 is added from the luminous layer section 24 by this in addition to the light L leaked to a direct li fetch layer side, optical fetch effectiveness can be raised. Moreover, in order to reduce total reflection loss further, th interface of the luminous layer section and an optical fetch layer can be turned in the optical fetch direction, and it ca also incurvate convex as indicated by JP,5-190893,A.

[0034] In the light emitting device 100 of drawing 1 , although each class of the luminous layer section 24 which makes terrorism structure to double was formed with AlGaInP mixed crystal, as shown in drawing 2 , blue or the wid gap mold light emitting device 200 for ultraviolet luminescence can also be constituted by forming in double each cl (p mold cladding layer 106, a barrier layer 105, and n mold cladding layer 104) of the luminous layer section 124 which makes terrorism structure with AlGaInN mixed crystal. the luminous layer section 124 -- the light emitting device 100 of drawing 1 -- the same -- MOVPE -- it is formed of law. Except for the luminous layer section 124, sin the remaining part is the same configuration as the light emitting device 100 of drawing 1 , the light emitting device 200 of this drawing 2 omits detailed explanation.

[0035] Moreover, a barrier layer 5 or 105 can also be constituted as that to which the laminating of two or more compound semiconductor layers from which bandgap energy differs was carried out in this, and a thing which specifically has quantum well structure as shown in drawing 10 (a), although formed as a monolayer with the above-mentioned operation gestalt. As shown in drawing 10 (b) and (c), the laminating of the barrier layer which has quant well structure is carried out in the form to which lattice matching of two-layer [two-layer / B / a band gap is mutuall different from with adjustment of a mixed-crystal ratio], i.e., the small well layer of bandgap energy, and the large barrier layer A is carried out so that it may become an electronic average free process or the thickness not more than (generally one atomic layer - 10A of numbers) respectively. With the above-mentioned structure, since the energy of the electron (or hole) of the well layer B is quantized, for example, when it applies to semiconductor laser etc., the width of face and the depth of an energy well layer can adjust oscillation wavelength freely, and there is effectivenes in stabilization of oscillation wavelength, improvement in luminous efficiency, the reduction that is oscillation threshold current density further. Furthermore, since thickness is very small, if the well layer B and a barrier layer A are to about 2 - 3%, a gap of a lattice constant is permitted and expansion of an oscillation wavelength field is also ea for them. In addition, quantum well structure may be good also as multiplex quantum well structure of having two or more well layers B, and as shown in (c), any are sufficient as it, as shown in (b) also as single quantum well structure having one layer of well layers B. drawing -- with 0.5(aluminum0.7Ga0.3) In0.5P mixed crystal, 0.5 (aluminum0.5Ga0.5) In0.5P mixed crystal constitutes a barrier layer A, and 0.5(aluminum0.2Ga0.8) In0.5P mixed crystal constitutes the well layer B for each cladding layer of p mold and n mold, respectively. In addition, the thickness of a barrier layer A can make only what touches a cladding layer about 500A, and others can be made into about 60A. Moreover, the well layer B can be made into about 50A.

[0036] As mentioned above, although the gestalt of operation of this invention was shown, this invention can add

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various amelioration or modification, unless it is not limited to this at all and deviates from the items mentioned of a claim. For example, with the above-mentioned operation gestalt, although the luminous layer section was formed wi AlGaInP mixed crystal or AlGaInN mixed crystal, GaP, GaAsP, or AlGaAs may form the luminous layer section wi other compound semiconductors, and the effectiveness of this invention described above also in this case can be attained.

[Translation done.]

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* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, when the transparence conductive layer which consists of ITO was formed on the current diffusion layer 107 which consists of AlGaAs mixed crystal according to the place which this invention persons examined, it turned out that the contact resistance of a transparence conductive layer and the current diffusion layer 107 tends to become high, and it is hard that it comes to avoid decline in the luminous efficien by series resistance increase.
[0008] It is by adopting the component structure which can make contact resistance of this electrode small to offer th light emitting device which can improve optical fetch effectiveness while an oxide transparent electrode layer is used for this invention as an electrode for a luminescence drive.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The mimetic diagram showing an example of the light emitting device of this invention by the laminate structure.
[Drawing 2] The mimetic diagram showing example of another of the light emitting device of this invention by the laminated structure.
[Drawing 3] The mimetic diagram showing the production process of the light emitting device of drawing 1 .
[Drawing 4] The mimetic diagram following drawing 3 .
[Drawing 5] The mimetic diagram showing the example of the component structure in which the electrode junctiona zone and the oxide transparent electrode layer were formed only on the first Lord front face of the luminous layer section.
[Drawing 6] The mimetic diagram showing the example of the component structure which inserted the reflecting lay in the second Lord front-face side of an optical fetch layer in drawing 5 .
[Drawing 7] The explanatory view showing the conventional structure and the conventional trouble of a light emittin device.
[Drawing 8] The mimetic diagram showing the example of the component structure in which the interlayer was form between the electrode junctional zone and the cladding layer.
[Drawing 9] The I-V property Fig. showing each VF value at the time of preparing various kinds of electrode junctio zones between AlGaInP and an ITO electrode layer.
[Drawing 10] The mimetic diagram of the barrier layer which has quantum well structure.
[Description of Notations]
4 N Mold AlGaInP Cladding Layer (Second Conductivity-Type Cladding Layer)
5 AlGaInP Barrier Layer
6 P Mold AlGaInP Cladding Layer (First Conductivity-Type Cladding Layer)
7 InGaAs Layer (Electrode Junctional Zone)
8 ITO Electrode Layer (Oxide Transparent Electrode Layer)
9 InGaAs Layer (Electrode Junctional Zone)
10 ITO Electrode Layer (Oxide Transparent Electrode Layer)
24 Luminous Layer Section
104 N Mold AlGaInN Cladding Layer (Second Conductivity-Type Cladding Layer)
105 AlGaInN Barrier Layer
106 P Mold AlGaInN Cladding Layer (First Conductivity-Type Cladding Layer)
50 51,100,200 Light emitting device

[Translation done.]

* NOTICES *

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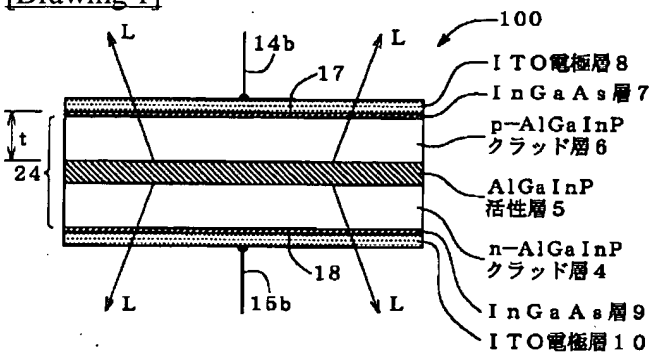
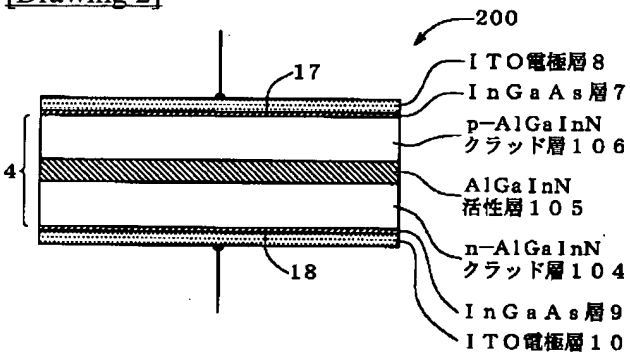
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

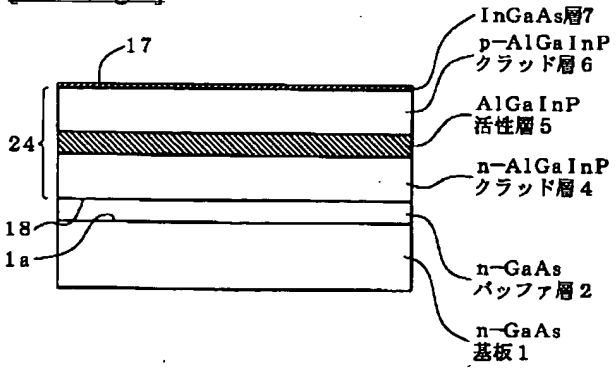
[Drawing 1]



[Drawing 2]



[Drawing 3]



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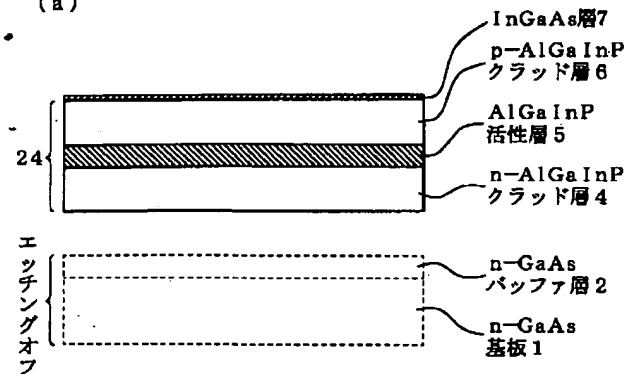
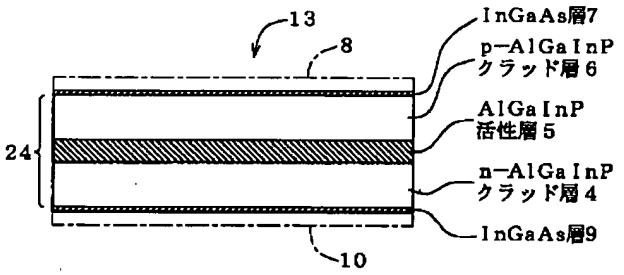
[Drawing 4]

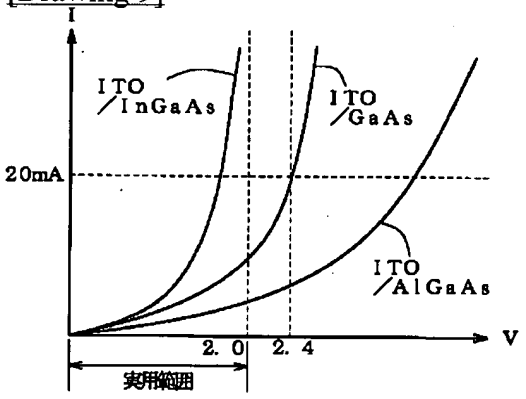
(a)



(b)



[Drawing 9]



[Drawing 5]

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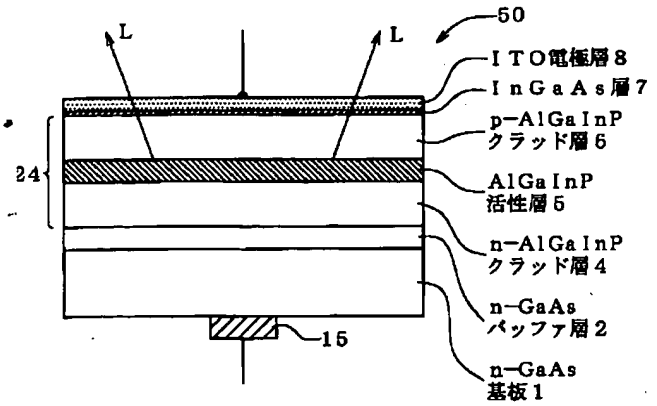
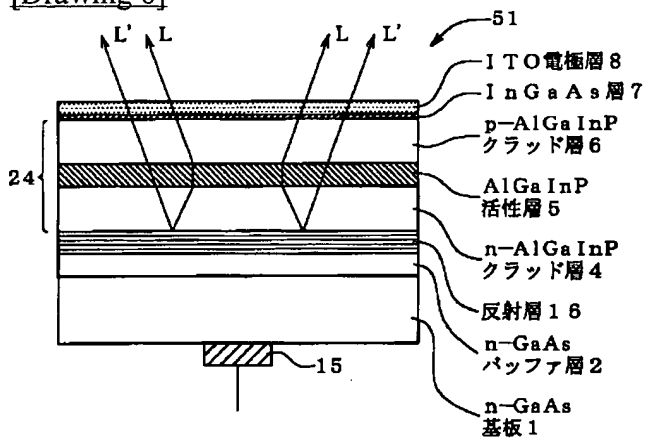
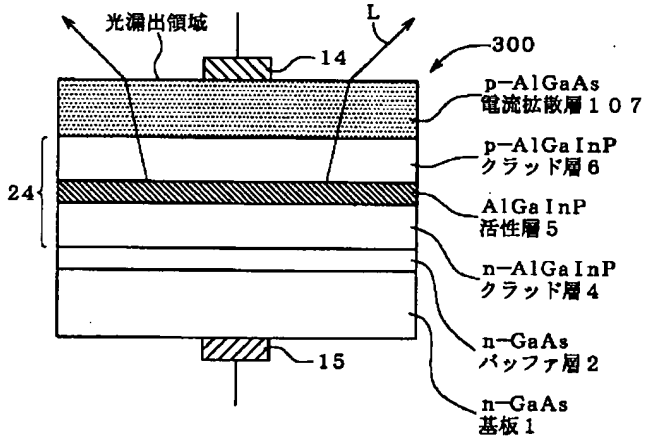


[Drawing 6]

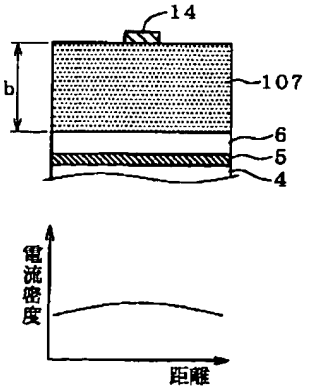


[Drawing 7]

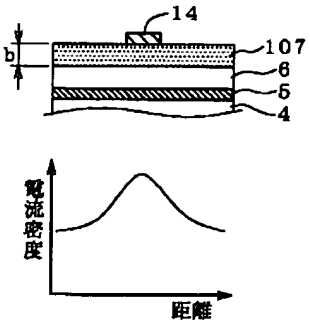
(a)



(b)

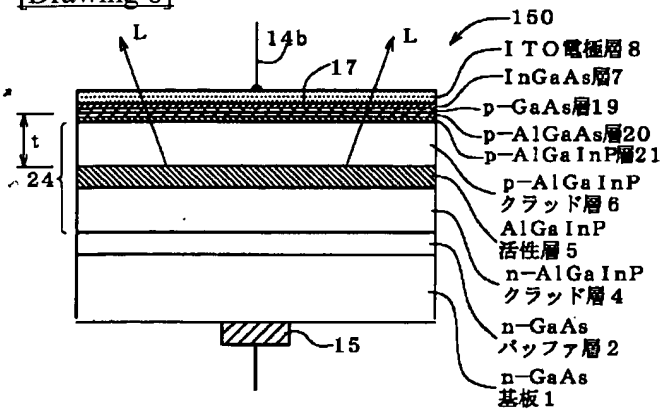


(c)



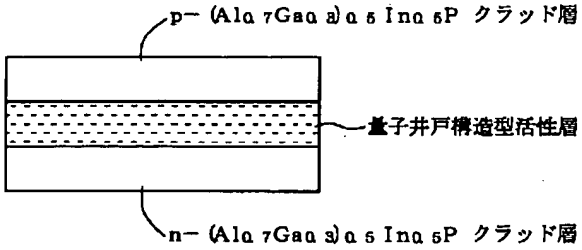
h c g cg b eb cg e e

[Drawing 8]

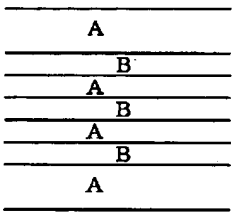


[Drawing 10]

(a)



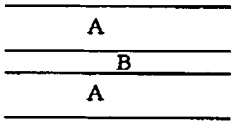
(b)



A= (Al0.5Ga0.5)0.5In0.5P

B= (Al0.2Ga0.8)0.5In0.5P

(c)



[Translation done.]